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USATECOM PROJECT NO 7-8-1018-06

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INITIAL PRODUCTION TEST OF MARGINAL TERRAIN ASSAULT BRIDGE WITH M113A1 LAUNCHER

(DAAK02-68-C-0226)

FINAL REPORT

BY

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AND

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SCIENTIFIC AND ENGINEERING

6 MAY 1969

US ARMY
ARMOR & ENGINEER BOARD
FORT KNOX, KENTUCKY

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DEPARTMENT OF THE ARMY
HEADQUARTERS, U.S. ARMY TEST AND EVALUATION COMMAND
ABERDEEN PROVING GROUND, MARYLAND 21005

AMSTE-GE 5 JUN 1969

SUBJECT: Final Reports on Initial Production Test of Marginal Terrain Assault Bridge with M113A1 Launcher, Contract No. DAAK02-68-C-0226, USATECOM Project No. 7-8-1018-05/06

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U. S. Army Mobility Equipment Command
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1. References:

a. Final Report on Initial Production Test of Marginal Terrain Assault Bridge with M113A1 Launcher (DAAK02-68-C-0226), USATECOM Project No. 7-8-1018-06, U. S. Army Armor and Engineer Board, 6 May 1969. (Incl 1)

b. Final Report on Initial Production Test of Marginal Terrain Assault Bridge with APC Launcher, USATECOM Project No. 7-8-1018-05, Aberdeen Proving Ground, May 1969. (Incl 2)

c. Letter, AMSME-QRT, USAMECOM, 7 January 1969, subject: "Marginal Terrain Assault Bridge, M113 Launcher; Contract No. DAAK02-68-C-0226, ENSURE 84, USATECOM Project No. 7-8-1018-05/06."

d. Letter, AMSTE-GE, USATECOM, 7 February 1969, subject: "Initial Production Test of Marginal Terrain Assault Bridge with M113 Launcher, Contract No. DAAK02-68-C-0226, ENSURE 84, USATECOM Project No. 7-8-101[illegible]-05/06."

e. Message DA 899062, ACSFOR, Department of the Army, 27 February 1969, subject: "Marginal Terrain Assault Bridge-Launched M113A1 Armored Personnel Carrier (ENSURE Nr. 84)."

2. Approval Statement: The subject final reports, references 1a and 1b, are approved except as noted herein.

3. Background of Test: The test item consists of two basic components - the bridge, a class 12 capacity aluminum bridge with a 33-foot length of

span; and the launcher, a modified M113A1 Armored Personnel Carrier (APC). The following tests were conducted under intermediate climatic conditions to contribute to the overall evaluation of suitability for release of the assault bridge:

a. Initial production test was conducted by Aberdeen Proving Ground from 20 August 1968 to 11 February 1969 to determine compliance with the initial production requirements of the purchase descriptions, and to determine the capabilities of the bridge to meet the essential requirements of the proposed Small Development Requirement.

b. Initial production test was conducted by U. S. Army Armor and Engineer Board from August 1968 to February 1969 to determine the degree to which the performance, reliability and maintainability of the assault bridge met user requirements.

4. Test Results:

a. The results of testing indicate that the item met 32 of the 45 essential performance requirements. It failed to meet 11 of the requirements and two requirements were not tested because of test termination. This test was initiated in August 1968 and numerous product failures were reported. On 30-31 December 1968, modifications intended to correct most of the problems were made to one test item at each test agency. Operation following these modifications indicated that the item was still unsatisfactory. The test item fails to meet essential requirements in the following respects:

(1) The weight of launcher and bridge in travel position exceeds the weight of the combat-loaded current APC by 1900 pounds.

(2) The evacuation of the crew from the test item is more difficult than from a standard APC. The driver's hatch cannot fully open and the cargo hatch cannot be opened with the bridge in travel position.

(3) Because of its narrow tread width, a ¼-ton truck has extreme difficulty crossing the bridge, and when the bridge is wet or covered with mud, it is treacherous to cross due to lack of curbs. The non-skid surface will not prevent a vehicle from sliding off the bridge.

(4) Placing the bridge without exposing the crew is difficult and crossing the bridge without a guide is considered hazardous. Exposure of a crew member is required to remount the bridge on the vehicle.

(5) The launcher will not retrieve a mud-laden bridge. The mud must be removed before recovery and requires an excessive amount of time.

(6) The equipment, as tested, does not possess sufficient ruggedness in design to withstand military service without requiring major overhaul or replacement for 750 kilometers or 500 launching cycles.

(7) The mean time between failures before modification was 54.24 kilometers and 44.63 launchings and after modification was 221.1 kilometers and 175 launchings. The requirement is for 240 kilometers or 240 launchings.

(8) The inherent availability was .953 before modification and .90 after modification, against a requirement of .925.

(9) The achieved availability was .894 before modification and .884 after modification, against a requirement of .90.

(10) Organizational maintenance of the launcher per 10 launchings before modification was .61 manhours and after modification was 0.08 manhours, against a requirement of .25. The manhour requirements for the bridge per 100 crossings was .30 manhours before modification and .72 manhours after modification, against a requirement of .33. In addition, the organization cannot weld the bridge with present instructions and requires a pressure gage, FSN 6685-581-5186, for diagnosis of the hydraulic system, which is not included in the maintenance package.

(11) The mean down time per 750 kilometers was 51.5 hours and the mean down time per 500 launchings was 34.2 hours during test, against a requirement of 2.0 hours in each case.

b. In general, the modifications made on 30-31 December were corrections to the component deficiencies reported in Appendix III of both reports. Since the testing was terminated after only limited testing of these modifications, the failures still appear as deficiencies in the reports. This headquarters believes that the modifications appear to be adequate and that the bridge will provide relatively maintenance-free operation for the first 150 to 200 launching cycles. Therefore, this headquarters agrees with the findings of the subject reports except for the classification of deficiencies listed in Appendix III of each report.

(1) Reference 1a, Appendix III, lists 16 deficiencies and 15 shortcomings. Fifteen of the deficiencies are reclassified as follows:

5 JUN 1969

AMSTE-GE

SUBJECT: Final Reports on Initial Production Test of Marginal Terrain Assault Bridge with M113A1 Launcher, Contract No. DAAK02-68-C-0226, USATECOM Project No. 7-8-1018-05/06

(a) The failure of the link beam flanges, paragraph 1.1; cylinder beam, paragraph 1.2; vertical braces, paragraph 1.3; tensile link, paragraph 1.6; link beam mounts, paragraph 1.11; rotating beam retaining bolts, paragraph 1.13; and sliding link, paragraph 1.15 are the result of the binding of the bridge hinge pins. These components were modified, which improved the bridge but did not correct the deficiency in the design of the bridge hinge. The binding of the hinge pins caused primarily by the vehicle crossing the bridge is considered to be the major component deficiency in the bridge.

(b) The failure of the hydraulic handles cotter pin, paragraph 1.5 and the hydraulic handles, paragraph 1.9 are related to the inadequate design in the handles. The handle design is considered to be deficient because it will not withstand the force applied by the operator during bridge launching.

(c) The lower surfboard mount failed because of insufficient strength. New mounts made from low alloy, high strength steel were installed. This, therefore, as indicated in the APG report, is a corrected deficiency.

(d) The hose retractors failed, paragraph 1.8, because they were bent and damaged, due to misalignment during retrieving operations. The redesigned quick disconnects and improved mounting are considered satisfactory. This, therefore, as indicated in the APG report, is a corrected deficiency.

(e) The failure of the hydraulic pump, paragraph 1.10 and the hydraulic system, paragraph 1.14, were caused by quality control and engineering problems, which caused premature pump wear. Modified pumps were installed and, although limited testing was conducted, the pumps are apparently satisfactory. Therefore, this deficiency is reclassified as a corrected deficiency.

(f) The failure of the launching cylinder was the result of leakage by threads and may have been due to a loose end connection. This failure only occurred on one cylinder out of seven tested. This, therefore, is considered to be a random failure.

(2) Reference 1b, Appendix III, lists three deficiencies and 19 shortcomings. The deficiencies are reclassified as follows:

(a) Control handle failure (paragraph 2) is the same as paragraph 4b (1)(b) above and is considered to be a deficiency in the design of the handle.

AMSTE-GE 5 JUN 1969

SUBJECT: Final Reports on Initial Production Test of Marginal Terrain Assault Bridge with M113A1 Launcher, Contract No. DAAK02-68-C-0226, USATECOM Project No. 7-8-1018-05/06

(b) Cracks appeared in the ramps (paragraph 2) is the same as paragraph 4b(1)(a) above and is considered to be a deficiency in the design of the bridge hinge.

(c) Front universal joint failure. This failure only occurred on the unit at APG. USAARENBD did not experience a similar difficulty, and since this is a standard part in the M113A1, this is considered to be a random failure.

(3) In summary, there remained three deficiencies at the time of test termination. These were the binding of the bridge hinge, the design failure of the hydraulic control handles, and the unsafe operating conditions during vehicle swimming.

5. Comments: Per request, reference 1c, and based on the fact that the item failed to meet the requirements indicated above, USATECOM, on 7 February, provided USAMECOM with a statement that the subject bridge was considered unsuitable for issue and took action to terminate the test (reference 1d). USATECOM also recommended that, in view of the urgent requirements, the customer be advised of the performance of the subject bridge and release of the item be contingent on customer reaction. In message, reference 1e, Department of the Army pointed out the problems encountered in testing the bridge and actions taken to preclude unsatisfactory performance. Message requested that user concur in DA proposal to deploy items for field evaluation. The user concurred in deployment of the items and items were released.

6. Conclusions: The conclusion made at the time of test termination, reference 1d, is reiterated at this time. Based on the fact that the item failed to meet requirements established, this headquarters considers the subject bridge unsuitable for release.

FOR THE COMMANDER:

2 Incls
as

WILLIAM H. HUBBARD
Colonel, GS
Deputy Chief of Staff

RDTE PROJECT NO

(16) USATECOM [redacted]-78-1018-06

(6) INITIAL PRODUCTION TEST OF

MARGINAL TERRAIN ASSAULT BRIDGE

WITH M113A1 LAUNCHER.

~~(DAAG39-68-C-0226)~~

TEST REPORT

(10) BY

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AND

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SCIENTIFIC AND ENGINEERING

(11) 6 MAY 1969 (12) 107p.

US ARMY ARMOR AND ENGINEER BOARD
Fort Knox, Kentucky

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TABLE OF CONTENTS

		PAGE
ABSTRACT		iv
FOREWORD		v
	SECTION 1. INTRODUCTION	
1.1	BACKGROUND	1
1.2	DESCRIPTION OF MATERIEL	1
1.3	TEST OBJECTIVE	2
1.4	SUMMARY OF RESULTS	2
1.5	CONCLUSION	5
	SECTION 2. DETAILS OF TEST	
2.1	INTRODUCTION	6
2.2	PREOPERATIONAL INSPECTION AND PHYSICAL CHARACTERISTICS	8
2.3	ROAD MOBILITY	10
2.4	CROSS-COUNTRY MOBILITY	10
2.5	INLAND WATERWAY OPERATIONS	11
2.6	COMPATIBILITY WITH RELATED EQUIPMENT	14
2.7	FUEL AND OIL CONSUMPTION	14
2.8	LAUNCHING AND RECOVERY	16
2.9	MAINTAINABILITY	20
2.10	RELIABILITY	24
2.11	HUMAN FACTORS ENGINEERING	36
2.12	TRAINING	38
2.13	TOOLS AND TEST EQUIPMENT	38
2.14	TECHNICAL MANUSCRIPTS AND MANUALS	39
	SECTION 3. APPENDIXES	
I	TEST DATA	I-1
II	FINDINGS	II-1
III	DEFICIENCIES AND SHORTCOMINGS	III-1
IV	MAINTENANCE EVALUATION	IV-1
V	REFERENCES	V-1
VI	DISTRIBUTION LIST	VI-1

ABSTRACT

The Initial Production Test of Marginal Terrain Assault Bridge with M113A1 Launcher was conducted by the US Army Armor and Engineer Board during the period 20 August 1968 to 11 February 1969, at Fort Knox, Kentucky. The test objective was to conduct service-type testing as required to insure that the test item is suitable for issue to troops under provisions of AMCR 700-34. The two test items accumulated a total of 99.7 test hours (80.7 hours before major modification and 19 hours after major modification) and 777.4 miles. Testing consisted of road operations (20.6 hours), swimming (2.6 hours), and launching/retrieving operations (76.5 hours) and was conducted under all local environmental weather conditions to include both day and night operations. The test items satisfied the essential requirement relating to human factors engineering. The essential requirements relating to road mobility, cross-country mobility, compatibility with related equipment, fuel and oil consumption, and launching and recovery were either not determined or not fully determined due to test termination. The test items failed to fully satify the essential requirements relating to physical characteristics, launching and recovery, maintainability, and reliability. Seventeen deficiencies were encountered during the test. Nine were against the bridge, seven were against the launcher and one pertained to a safety hazard in that emergency evacuation in the event of sinking was considered inadequate. The deficiencies pertained to link beam flanges and mounts, cylinder beam to include bushings, vertical braces, hydraulic reservoir, tensile link, surfboard mounts, hose retractors, sliding link, rotating beam retaining bolts, and the hydraulic system to include the pump. One test item received modification at 44.2 test hours to correct repeated failures. The other test item became deadlined at 36.5 test hours and remained in that status until test termination. Of the seven modifications applied during test, two proved unsatisfactory (launch handle and cylinder beam bushings), one proved satisfactory (hydraulic reservoir), and four could not be thoroughly evaluated due to test termination. The overall reliability for a 12-hour mission at 90 percent confidence was computed to be 35 percent before and 47 percent after major modification. The overall MTBF was 23.55 launches before and 58.33 launches after major modification. The overall MTTR was .67 clock-hours before and 3.40 clock-hours after modification. The overall maintenance ratio was 1.19 before and 1.21 after major modification. It was concluded that the test item as received and as modified during test is unsuitable for troop issue.

FOREWORD

The Engineer Division, United States Army Armor and Engineer Board, was responsible for preparation of the test plan, execution of test, and preparation of the test report. This project was conducted under the authority contained in ref 1, app V.

SECTION 1. INTRODUCTION

1.1 BACKGROUND

1.1.1

In late 1965, an urgent request was made for a light assault bridge to be employed with the M113 Armored Personnel Carrier. The present class 60 Armored Vehicle Launched Bridge did not possess the swimming capabilities or the low ground pressure required for this type of equipment. In response to this request, an expedient deck balk bridge was developed using available standard equipment. However, studies of the general problem and the operating environment and requirements were continued. As a result, a light assault bridge structure was developed which could be transported, launched, and retrieved by the M113 in combat operations over wet and dry gaps, particularly in marginal terrain environments.

1.1.2

A proposed Small Development Requirement (SDR) for a Marginal Terrain Assault Bridge with M113 Launcher was prepared by US Army Engineer Research and Development Laboratories (subsequently redesignated US Army Mobility Equipment Research and Development Center (USAMERDC)). In order to provide suitable criteria for this test, changes to the proposed SDR were made by USACDC and implemented by USATECOM. Subsequently, further changes were made to the modified SDR by USAMERDC and incorporated at the direction of USAMC. Subsequent changes were made by USACDCEA and USACDCMA based on the ENSURE requirement.

1.2 DESCRIPTION OF MATERIEL

The test item consists of two basic components - the bridge, a class 12 capacity aluminum bridge with a 33-foot length of span; and the launcher, a modified M113A1 Armored Personnel Carrier (APC).

1.2.1 Bridge

The major components of the bridge are four tapered box sections, king pins, and horizontal and vertical cross braces. In addition to the use of weldable aluminum alloy (7039), the bridge features a nonecentric hinge employed at the juncture of the two folding leaves; thus providing a completely flush bottom flange.

1.2.2 Launcher

The launching operation is similar in principle to that of the standard AVLB, but major changes eliminate the use of a tongue cylinder in the launcher and cables and quadrant in the bridge. The hydraulically operated launching mechanism is connected to the M113A1 vehicle at six points, which are pin connections to weldments modifying the vehicle. The external launching system consists of two launching cylinders, a locking cylinder for positive connection to the bridge, and necessary hydraulic lines and control valves. Power take-off components attached to the power plant drive a hydraulic pump which provides a combination of control and relief valves with 3,300 psi hydraulic pressure. The hydraulic reservoir and controls are located directly behind the vehicle engine compartment.

1.2.3

Two test items, serial numbers 53 and 54, were received on 19 August 1968, by USAARENBD for test.

1.3 TEST OBJECTIVE

To conduct service-type testing as required to insure that the test item is suitable for issue to troops under provisions of AMCR 700-34.

1.4 SUMMARY OF RESULTS

1.4.1

Results are based on the operation of two test items for a total of 99.7 test hours (80.7 hours before major modification and 19 hours after major modification), 777.4 miles or 1,251.7 kilometers, 1,023 launches, and 16,345 crossings. The miles were accumulated primarily during launch operations with the remainder being accumulated on hard surface and gravel roads and swimming operation crossings were accomplished by standard military vehicles up to and including the combat-loaded M113A1 APC. The launching cycle is complete to include launching and retrieving. One test item (serial number 53) received major modifications at 44.2 test hours. The short duration after modification did not allow for sufficient time to thoroughly test and subsequently evaluate the modifications, except for the hydraulic reservoir, which was considered satisfactory. The other test item (serial number 54) became deadlined at 36.5 test hours and remained in that status until test termination.

1.4.2

The test items satisfied the essential requirement relating to human factors engineering.

1.4.3

The essential requirements relating to road mobility and cross-country mobility were not determined prior to termination of test.

1.4.4

The essential requirements relating to compatibility with related equipment and fuel and oil consumption were met insofar as tested prior to test termination. The following tests were not accomplished:

1.4.4.1 Towing other items.

1.4.4.2 Comparison fuel check with a current APC.

1.4.5

The test items failed to fully satisfy the essential requirement relating to physical characteristics, launching and recovery, maintainability, and reliability. Also the ability of the test item to span sloping gap sites was not determined prior to test termination.

1.4.5.1 The combat-loaded test item weighed 1,900 pounds more than a combat-loaded M113A1.

1.4.5.2 The test item failed to provide armor protection for the crew, in that the head and shoulders must be exposed when emplacing the bridge.

1.4.5.3 The test item was more difficult to maintain than the M113A1 mainly due to the lack of adequate instructions in the maintenance manual.

1.4.5.4 Organizational maintenance services performed exceeded the 4.5 man-hours per maintenance action specified in the criteria. A quarterly service required 12.9 man-hours and a simulated bridge removal maintenance action required 7.5 man-hours.

1.4.5.5 The scheduled and unscheduled organizational maintenance was .61 man-hour per 10 launches before major modification which exceeded the criterion of .25 man-hour. The maintenance man-hour requirement for the bridge per 100 vehicle crossings was .72 after modification, which exceeded the criterion of .33 man-hour.

1.4.5.6 The test item did not possess sufficient ruggedness in that major modification was required after 472 launches and 356.9 test miles because of repeated failures.

1.4.5.7 The overall MTBF for the launcher before modification was 60.03 launches and 44.63 kilometers, and 175 launches and 221.1 kilometers after modification as compared to the criteria of 240 launches or 240 kilometers.

1.4.5.8 The overall MTBF for the bridge before modification was 49.88 launches and 807.05 crossings, and 87.50 launches and 1,312.50 crossings after modification as compared to the criteria of 240 launches or 3,600 crossings.

1.4.5.9 The inherent availability after modification was 90 percent as compared to 92.5 percent required.

1.4.5.10 The achieved availability before modification was 89.4 and 88.4 percent after modification as compared to 90 percent required.

1.4.5.11 Sixteen reliability deficiencies (modifications not applied or applied, but not sufficiently tested) were encountered during test. Repeated failures were experienced with the link beam flanges and mounts, vertical braces, hydraulic control handles, hose retractors and rotating beam retaining bolts. In addition, 14 reliability shortcomings were encountered throughout the test.

1.4.6

The essential requirement related to inland waterway operations was not met in that emergency evacuation of crew in the event of sinking was considered inadequate (deficiency).

1.4.7

The essential requirement related to technical manuals was not met in that lifting and tiedown instructions for air, rail, or water shipment were not provided.

1.5 CONCLUSION

The US Army Armor and Engineer Board concludes that the Marginal Terrain Assault Bridge with M113A1 Launcher and as in-test modified is unsuitable for troop issue.

SECTION 2. DETAILS OF TEST

2.1 INTRODUCTION

2.1.1

Tests were conducted by the Engineer Division, US Army Armor and Engineer Board (USAARENBD) at Fort Knox, Kentucky and vicinity utilizing the plan of test (ref 2, app V).

2.1.2

Prior to initiation of test operations, test personnel received appropriate familiarization instructions in care, handling, and employment of test materiel.

2.1.3

Throughout all operational testing, the test items were used in operations or missions which typify normal usage of the equipment by troops in the field.

2.1.4

Test operations were conducted in darkness as well as in daylight, and in all prevailing weather conditions, except when such conditions compromised test results or endangered life or property. The test items were exposed to the weather at all times throughout the test, except when sheltered for maintenance.

2.1.5

Normal safety regulations for water operations were enforced by test supervisory personnel.

2.1.6

Testing was conducted as expeditiously as practicable with the goal of accumulating a minimum of 1,000 kilometers of operation and 1,000 launch/retrieve cycles on each test item.

2.1.7

Throughout testing, the test items were operated and maintained in accordance with the instructions in pertinent equipment publications. Safety precautions contained therein were followed.

2.1.8

In all tests, the test items carried a three-man crew, except during swimming operations.

2.1.9

Unless the bridge was being launched, trafficked, or retrieved, it remained in position on the launcher under all test conditions.

2.1.10

Photographs and motion pictures were taken as appropriate to illustrate test results including test item faults.

2.1.11

Throughout all testing, the test items were evaluated against the pertinent characteristics in the amended SOR, a tabulation of which is in App II, Findings.

2.1.12

The standard M113A1 Armored Personnel Carrier was used as a comparison vehicle during the road mobility, inland waterway operations, compatibility with related equipment, fuel and oil consumption, and maintainability tests. (Data available from TM9-2300-224-10/2/1 Part One, September 1964, of the standard M113A1 were used where practicable.)

2.1.13

Testing was suspended on 22 November 1968, due to numerous test item failures (ref 3, app V).

2.1.14

One test item (Ser No 53) underwent major modifications (part 3, app I) by USAMERDC and testing was resumed on 2 January 1969. The other test item (Ser No 54) was permanently deadlined.

2.1.15

Testing was again stopped on 29 January 1969, due to recurring failures. A msg report was submitted to USATECOM on 1 February 1969 (ref 4, app V) in preparation for a Predeployment

Conference held on 11-12 February 1969, at USATECOM. A release of the item in the ENSURE program as described in AMCR 700-34 (ref 5, app V) was obtained as a result of the conference.

2.1.16

The test was terminated on 11 February 1969, by ref 6, app V.

2.2 PREOPERATIONAL INSPECTION AND PHYSICAL CHARACTERISTICS

2.2.1 Objectives

2.2.1.1 To insure that the test items are in proper condition for test operations.

2.2.1.2 To provide necessary driver and crew familiarization.

2.2.1.3 To record pertinent physical characteristics of the test item.

2.2.1.4 Criteria

a. The weight of launcher and bridge in travel position will not exceed the weight of the combat-loaded current APC.

b. The launcher (vehicle and mechanism) with bridge in travel position will have as low a profile as possible but not to exceed a height of 12 feet.

2.2.2 Method

2.2.2.1 Upon receipt, the test items were subjected to a preoperational inspection, serviced in accordance with instructions contained in equipment publications, photographed, and checked for pertinent physical characteristics.

2.2.2.2 One launcher with bridge was weighed.

2.2.2.3 The height of the launcher with bridge in the travel position was measured.

2.2.2.4 Test items were operated as required to accomplish crew familiarization.

2.2.3 Results

2.2.3.1 The combat-ready test item weighs approximately 25,980 pounds. A combat-loaded M113A1 weighs 24,080 pounds. The test item was operated at approximately 24,700 pounds.

2.2.3.2 The height of the launcher and bridge in the travel position is 11 feet 2 inches.

2.2.3.3 During preoperational inspection, one ramp section was found to have a bent and cracked cross web. The web was straightened and welded. (See para 2.1.1, app III.)

2.2.3.4 During preoperational inspection, one launching cylinder required adjustment after a severe hydraulic leak was noted. The cylinder lock ring had not been properly torqued. (See para 1.12.1, app III.)

2.2.3.5 The following pretest data was obtained from the test items:

Serial No (vehicle/launcher)	53	54
USA No	12B66668	12B09968
USAARENBD No	T-364	T-365
Odometer miles on receipt	46.0	40.0
Tachometer hours on receipt	5.0	5.0
Odometer miles at start of test	90.1	63.0
Tachometer hours at start of test	8.7	6.8

2.2.3.6 Descriptive photographs are found on pages I-2 through I-5, app I.

2.2.3.7 All principal components, attachements, accessories, and on-equipment materiel (OEM) (as listed in sec II, app C, DTM 5-5420-206-15, Jun 68) were received with the test items.

2.2.3.8 No difficulties were encountered in driver/crew familiarization.

2.2.4 Analysis

2.2.4.1 The failure to meet the weight criterion stated in para 2.2.1.4a is a potential detriment to the vehicle suspension. Also, the temptation to utilize the space inside the vehicle during combat increases the danger to the suspension system.

2.2.4.2 The criterion stated in para 2.2.1.4b was met.

2.3 ROAD MOBILITY

2.3.1 Objective

2.3.1.1 To determine the road mobility characteristics of the test vehicle.

2.3.1.2 Criterion. The test vehicle will have mobility equivalent to the standard M113, except as affected by the changed center of gravity location resulting from the bridge/launcher mounting.

2.3.2 Method

2.3.2.1 The test vehicles were operated in daylight and at night to a limited degree, under various weather conditions, on roads together with other vehicles with which they would normally be associated in a convoy to include lead and last position. The ability of the vehicles to maintain their position in the convoy and to maintain the prescribed convoy speed was noted.

2.3.2.2 No other road mobility testing was performed because of test termination.

2.3.3 Results

The test items were able to maintain their position at normal convoy speeds.

2.3.4 Analysis

The test criterion as stated in para 2.3.1.2 could not be fully evaluated according to the plan of test. However, based on observation of the test items during launching operations, the road mobility of the items did not appear to differ significantly from a standard M113A1.

2.4 CROSS-COUNTRY MOBILITY

2.4.1 Objective

2.4.1.1 To determine cross-country mobility characteristics of the test vehicle.

2.4.1.2 Criterion. The test vehicle will have mobility equivalent to the standard M113, except as affected by the changed center of gravity location resulting from the bridge/launcher mounting.

2.4.2 Method

2.4.2.1 Cross-country mobility was not fully tested according to the plan of test because of test termination except when certain conditions were encountered during other tests.

2.4.2.2 The vehicles were driven forward, backed up, and held stationary headed up and down on longitudinal slopes up to 45 percent in conjunction with inland waterways operation.

2.4.3 Results

The test items successfully negotiated the slopes described in para 2.4.2.2.

2.4.4 Analysis

The test items were not evaluated against the criterion stated in para 2.4.1.2. However, the test items could obviously not possess the cross-country mobility characteristics of the standard M113A1 regardless of the changed center of gravity location, because of the overhead and side clearance necessary for the launcher and bridge components in the travel position. This would apply to travel in close woods and on narrow winding trails.

2.5 INLAND WATERWAY OPERATIONS

2.5.1 Objectives

To determine:

2.5.1.1 The capability of the test vehicle to operate through inland waterways.

2.5.1.2 The slope and condition of banks that can be negotiated when entering and leaving the water.

2.5.1.3 The effects of water operations on the operational characteristics of the test vehicle.

2.5.1.4 Criterion. The swimming characteristics of the test item with bridge in travel position will equal that of the standard M113,

except as affected by the changed center of gravity location resulting from the bridge/launcher mounting.

2.5.2 Method

2.5.2.1 The test vehicles were operated in Engineer Lake (still water) at Fort Knox just prior to a scheduled organizational maintenance service. The following was noted:

a. Maneuverability.

b. Adequacy of freeboard both when underway and when floating.

c. Adequacy of vision.

d. Attitude of the vehicles in water.

e. Effects of water operation on sealing, lubrication, power train operation, materiel, launching mechanism, and personnel both when underway and when floating.

f. Adequacy of provisions for evacuation of crew in event of sinking.

g. Adequacy of bilge pumps.

h. The slope and condition of banks that can be successfully negotiated when entering and leaving the water.

2.5.2.2 The vehicles were not operated in the Ohio River because of test termination. Therefore, the ability to operate in and attainable speeds in various current velocities were not determined.

2.5.3 Results

2.5.3.1 Surfboard mounts failed during land operations. (See para 1.7 and 2.9, app III.) Lower mounts are most critical to water operation since failure would undoubtedly cause sinking. Modified lower mounts were installed on test item 53 during testing, however, insufficient testing after modification prevented evaluation.

2.5.3.2 The test items are as maneuverable in water as the standard M113A1.

2.5.3.3 The measured freeboard of the test item when underway and floating was greater than that of a standard M113A1 by 2 inches at

the bow and 3 inches at the stern of the vehicle (measured on the side of the vehicles). The operating weight was approximately 24,700 pounds for the test vehicle as compared to 24,080 pounds for the standard M113A1. Even though the test item is heavier than the standard M113A1, its increased freeboard can be attributed to the buoyancy received by the addition of the surfboards on the test item. The surfboards are part of the kit that converts the M113A1 vehicle into the marginal terrain assault bridge. (See page I-2, app I.)

2.5.3.4 In spite of the greater freeboard of the test vehicles, the bow wave completely inundated the surboards while underway. Water sometimes reached the top of the vehicle. On a standard M113A1 the bow wave was pushed ahead by the trim vane.

2.5.3.5 Although the field of vision for both driver and commander/operator is less for the test items than for a standard M113A1, vision is deemed adequate for swimming.

2.5.3.6 Water operation had no observed adverse effect on sealing, lubrication, power train operation, materiel, or launching mechanism of the test items. However, the forward bilge outlet sprays into the driver's hatch because of impingement of the discharge on the port launching beam. This affects the driver's comfort but not the bilge pump capacity.

2.5.3.7 The provisions for crew evacuation in event of sinking are considered inadequate. (See para I.15, app III.) The bridge structure in the travel position blocks a direct upward exit from the vehicle. The driver is forced to crawl between the top of the vehicle and the bridge to the stern or bow and then over the side. The commander/operator would either crawl to the side under the bridge or thread his way upward through the bridge bracing. The third crewman must follow the commander. Water operation was considered safe during testing, because of the presence of two divers and only two crewmen were used.

2.5.3.8 The slope of the bank used to enter and leave the water was gradual (less than 10 percent) and the condition was muddy. The 45-degree slope described in para 2.4.2.2 was not the entry slope.

2.5.3.9 Although actual swimming speeds were not obtained because of the small size of the lake, observation of the test items and a standard M113A1 together in the water indicated there was no appreciable difference in speed.

2.5.3.10 Motion pictures were taken showing all phases of water operation. Still pictures were also obtained. (See photo, page I-5, app I.)

2.5.4 Analysis

The criterion stated in para 2.5.1.4 was not met because of the lack of adequate provisions for emergency crew evacuation as explained in para 2.5.3.7.

2.6 COMPATIBILITY WITH RELATED EQUIPMENT

2.6.1 Objective

2.6.1.1 To determine the compatibility of the test vehicle with related vehicles and equipment.

2.6.1.2 Criterion. The test vehicle will be provided with connections permitting it to be towed and to tow equivalent to the current APC.

2.6.2 Method

2.6.2.1 The test vehicles were recovered by M543, 5-ton wreckers and were towed by M113A1 vehicles as was necessary in conducting other performance tests.

2.6.2.2 The test items were not used to tow other vehicles due to test termination.

2.6.3 Results

No problems were encountered during towing of the test items.

2.6.4 Analysis

The criterion stated in para 2.6.1.2 was partially met in that it could be towed and was compatible with towing equipment. The test item did not tow other vehicles and, therefore, this portion of the criterion was not evaluated.

2.7 FUEL AND OIL CONSUMPTION

2.7.1 Objectives

2.7.1.1 To determine the fuel and oil consumption and cruising range of the test vehicle.

2.7.1.2 To determine the capability of the vehicles to accept fuel from standard refueling equipment.

2.7.1.3 Criteria

a. Launcher must operate utilizing standard Army fuel and lubricants.

b. Equipment must have sufficient fuel capacity for a distance traveled equal to the current APC.

2.7.2 Method

2.7.2.1 The vehicles were operated on hard-surface and gravel roads only for the purposes of movement to new sites and performing maintenance.

2.7.2.2 Fuel consumption on hard-surface and gravel roads and cross country was not determined because of test termination.

2.7.2.3 Overall fuel and oil consumption was measured throughout all testing.

2.7.2.4 Usable fuel capacity and time required to refill fuel tanks was not determined because of test termination.

2.7.3 Results

2.7.3.1 The test vehicles operated on standard Army fuel and lubricants with no noticeable adverse effects.

2.7.3.2 No problems were encountered during the refueling process.

2.7.3.3 The fuel consumption was as follows:

a. For test item Ser No 53: 536 gal for 494.1 test miles for 1.1 miles/gal.

b. For test item Ser No 54: 320 gal for 283.3 test miles for 1.1 miles/gal.

c. The overall fuel consumption was 1.1 miles/gal.

2.7.3.4 The engine oil consumption less regular oil changes was as follows:

a. For test item Ser No 53: 1.6 qt per 100 test miles.

b. For test item Ser No 54: 1.1 qt per 100 test miles.

c. The overall oil consumption was 1.42 qt/100 test miles.

2.7.3.5 The hydraulic oil consumption was as follows:

a. For test item Ser No 53: 0.96 qt per 10 launches plus an additional 168 qt resulting from hydraulic reservoir ruptures and pump removal.

b. For test item Ser No 54: 1.12 qt per 10 launches plus an additional 112 qt resulting from hydraulic reservoir ruptures.

c. The overall hydraulic oil consumption was 1.02 qt/10 launches plus an average of 140 qt resulting from hydraulic problems.

2.7.4 Analysis

2.7.4.1 The criterion stated in para 2.7.1.3a was met.

2.7.4.2 The criterion stated in para 2.7.1.3b was not evaluated.

2.8 LAUNCHING AND RECOVERY

2.8.1 Objective

2.8.1.1 To determine the launching and recovery characteristics of the test items.

2.8.1.2 Criteria

a. The bridge shall be capable of spanning gaps up to and including 33 feet.

b. The bridge shall be capable of sustaining all standard military vehicles up to and including a combat-loaded M113A1.

c. The bridge shall be capable of being launched and retrieved on sites when:

(1) The launcher is positioned on an 8-percent side slope.

(2) The slope between the launching plane and the far shore is as large as plus 15 percent or minus 10 percent.

d. The bridge shall be capable of being emplaced without site improvement.

e. The equipment will be capable of launching the bridge without exposing the crew while providing armor protection equivalent to the current M113 APC.

f. The bridge shall be capable of being recovered from either bank by the launching vehicle.

g. The bridge will be capable of immediate use after launch.

h. The equipment will be capable of launching and recovering the bridge in the folded or travel position for ease of transport operations.

i. The turnaround time shall not exceed 30 minutes (20 minutes desired), assuming no repairs are necessary. This is the time required to service and check out the material for recommitment, beginning from engine shutdown to restarting the engine.

j. The vehicle reaction time shall not exceed 2 minutes in the intermediate zone. This is the time required for the operator in position to start the engine and move the launcher with the bridge in travel position.

k. The time required for the bridge to be launched once the launcher is at the gap site is 3 minutes. This interval includes the time to emplace the bridge and back the launcher away to allow other vehicles to pass.

m. The time for the launcher to remount the bridge into travel position shall not exceed 10 minutes in the intermediate zone. (This includes connection of hydraulic components as required.)

2.8.2 Method

2.8.2.1 The test item was not launched and recovered on sites under conditions indicated in para 2.8.1.2c without site preparation because of test termination.

2.8.2.2 The test vehicle was driven 1 kilometer and the bridge launcher over a gap. After the bridge was launched, the launching mechanism was raised to travel position and the launcher then proceeded with other vehicles over the bridge. (During launch, exposure of the crew was noted.)

2.8.2.3 The test bridges were not launched or recovered in the folded configuration due to test termination.

2.8.2.4 The supporting vehicles formed a circular traffic pattern in order to obtain a continuous flow of traffic over the test bridge.

2.8.2.5 Each time the test bridge was launched, it was trafficked a total of 15 crossings.

2.8.2.6 Throughout the recovery operations, the bridge was retrieved from either end on an equal basis.

2.8.2.7 Throughout the test, description of operations performed, the conditions under which they were accomplished, and significant characteristics of the test item having an effect on performance were recorded.

2.8.2.8 The bridge was tested, to the extent practicable, on gaps where the banks included, but were not limited to, the following soil conditions.

a. Sandy bank with dry gap.

b. Clay bank with dry gap.

c. Clay bank with wet gap.

2.8.2.9 A gap with the far shore inundated, similar to a rice paddy, was not included because of test termination.

2.8.2.10 An M551 Sheridan, a class 16 load, was not driven across the bridge due to test termination.

2.8.3 Results

2.8.3.1 During testing, the bridge was successfully used to span gaps ranging from 25 to 33 feet.

2.8.3.2 The bridge sustained all standard military vehicles (tactical) up to and including combat-loaded M113A1 with the following exceptions.

a. An M38A1 1/4-Ton Truck (Std B) could not be guided across the bridge because of its narrow tread span.

b. In wet or muddy conditions crossings were difficult to negotiate for all vehicles, because of side slippage.

2.8.3.3 The bridge was emplaced on rough (i.e., unimproved) sites with soft soil. In certain of these instances when the bridge and

launcher were on different lateral planes, the launcher would not disengage from the bridge and the position of the bridge had to be altered slightly. During retrieval, in these cases, the engagement of the launcher locking pins in the bridge sockets was difficult and a great deal of practice for the third crewman was necessary so that he could properly direct the vehicle driver and commander/operator. Blocking of one side of the bridge was seldom necessary.

2.8.3.4 The launcher does not provide adequate armor protection during launch operations because it requires exposure of the head and shoulders of the two crew members to properly emplace the bridge.

2.8.3.5 The turnaround time was consistently under 30 minutes.

2.8.3.6 The vehicle reaction time averaged less than 15 seconds.

2.8.3.7 The time required to launch the bridge once the launcher was at the gap was normally 1 and 1/2 minutes. The launch time exceeded 3 minutes for 2.5 percent of the test launches but this was considered an insignificant amount.

2.8.3.8 The time for the launcher to remount the bridge into the travel position (including connection of hydraulic components) was normally 2.5 to 3 minutes. The retrieval time exceeded 10 minutes for 1 percent of the test launch cycles but this was considered an insignificant amount.

2.8.3.9 The hydraulic system would not lift (retrieve) a mud-covered bridge with an estimated 400 pounds of mud, deposited by crossing vehicles. (See para 2.11, app III.) Crew members scraped the bridge roadway clean and the retrieval operation was completed.

2.8.3.10 The bridge was capable of immediate use after launch.

2.8.4 Analysis

2.8.4.1 The criteria stated in para 2.8.1.2a, b, d, f, g, i, j, k, and m was met. However, caution must be exercised during crossing operations under wet or muddy conditions. Also, the retrieval time will assuredly exceed the criterion time in muddy environments in order to allow for mud removal.

2.8.4.2 The criterion stated in para 2.8.1.2e was not met.

2.8.4.3 The criteria stated in para 2.8.1.2c and h were not evaluated.

2.9 MAINTAINABILITY

2.9.1 Objective

2.9.1.1 To determine whether the item meets maintenance and maintainability requirements.

2.9.1.2 Criteria

a. The launcher shall possess the maintenance characteristics of the current APG. The installation of the launcher equipment will not significantly increase the practicable time, degree of skill, or variety of tools required for maintenance.

b. Crew maintenance shall not average more than 1.0 man-hour per 12-hour mission (exclusive of daily 'A' services). (Crew maintenance limited to cleaning, minor lubrication, adjustments, replacement of modules and minor components.)

c. Unit (organizational) maintenance services performed shall not exceed 4.5 man-hours per maintenance action including diagnostic time. Scheduled and unscheduled organizational maintenance (excluding operator/crew daily services) shall not exceed .25 man-hour per hour of operation or 10 launchings for the vehicle/launcher. Man-hour requirements for the bridge shall not exceed .33 per 100 vehicle crossings. (Unit organizational maintenance limited to minor adjustments of components and replacements of assemblies.)

d. Direct support maintenance services performed shall not exceed 12 man-hours for diagnosis and repair per maintenance action. (Direct support maintenance performed will include technical inspection and support assistance to units by contact teams in the repair or replacement of components, assemblies, and parts.)

e. The mean down time per 1,000 miles or 500 launches shall not exceed 2.0 hours for all unscheduled organizational and direct support maintenance.

2.9.2 Method

2.9.2.1 Operator/crew and scheduled preventive maintenance services prescribed for the test item were performed. All authorized organizational maintenance operations listed in the maintenance allocation chart were performed. The time required for all services and each maintenance operation was recorded. A sampling of direct and general support maintenance was accomplished. Data were obtained during the performance of daily, scheduled, and unscheduled maintenance to the

maximum extent practicable. Operator and organizational maintenance was performed under field operating conditions during all prevailing weather conditions. The following areas were noted:

a. Any increase in the time to accomplish a given maintenance operation and any decrease in the interval between routine maintenance operations as a result of extended usage.

b. Unduly difficult tasks, operations that require excessive time, and design deficiencies prejudicial to ease of maintenance.

c. Human factors implications and safety aspects of the maintenance operations.

d. Interchangeability of parts replaced.

2.9.2.2 Repair parts provided with the test item were compared with repair parts used during test and the list of repair parts in the pertinent manual.

2.9.2.3 Adequacy of stowage compartments for operator/crew tools and on-vehicle repair parts was noted.

2.9.2.4 Active maintenance time for the test item was computed by adding the following:

a. Operator/crew time spent in replacing parts and assisting mechanics.

b. Organizational maintenance personnel time spent in performing all scheduled and unscheduled maintenance.

c. All direct support and general support maintenance personnel time.

2.9.2.5 The maintenance ratios for each test item were computed by dividing the total active maintenance time in man-hours expended (less operator/crew daily services) on that test item during test by the total operating hours/miles accumulated by that test item. The overall maintenance ratio for all test items was computed by dividing the total active maintenance time in man-hours for all test items by the total operating hours/miles for all test items.

2.9.2.6 The mean down time for the test items was computed by dividing the clock-hours for all unscheduled organizational and direct support maintenance by the total maintenance actions. Inasmuch as only 777.4 test miles were accrued (both test vehicles) the mean down time per 1,000 miles was not computed.

2.9.3 Results

2.9.3.1 The time in man-hours expended in maintaining the test items at each maintenance level are indicated in part 1, app IV, and are shown for each vehicle and repair part group in part 3, app I. This time is summarized below as follows:

Maintenance Level	Vehicle Ser No 53		Vehicle Ser No 54	
Organizational	Man-hours	Clock-hours	Man-hours	Clock-hours
Scheduled	12.9	11.0	0.0	0.0
Unscheduled	62.1	38.5	35.3	24.5
Direct Support	7.7	5.7	1.0	1.0
Total (active)	82.7	55.2	36.3	25.5
Operator/Crew	32.0		18.0	

The operator/crew time shown above is preventive-type maintenance and is not included in active maintenance time. The operator/crew time shown in part 3, app I, although unscheduled, is considered preventive in nature and is included above along with cleaning, minor lubrication, and ajustment functions.

2.9.3.2 There was no notable increase in the time required to accomplish a given maintenance operation, nor was the time interval between maintenance operations shortened as a result of extended usage of the test items.

2.9.3.3 No unduly difficult maintenance operations were encountered by organizational and direct support level personnel during the test. The time required to replace defective parts was considered to be normal. However, 18.0 man-hours were required to weld a crack in the link beam mounting seat on vehicle Ser No 53. This excessive time represents difficulties and problems due to incorrect technical manual instructions and procedures.

2.9.3.4 No human factor engineering implications or safety hazards were encountered at the organizational or direct support maintenance level.

2.9.3.5 Most of the repair parts expended were furnished on an as-required basis. The modified replacement hydraulic oil reservoirs (both test items) were not interchangeable with the part removed.

The hydraulic oil pump mounting hole was too small to receive the pump and the modified reservoir lacked a drain hole. (See para 2.6.2 and 2.6.3, app III.) Otherwise all repair parts used were interchangeable. For a complete list of repair parts used, see part 2-B, app IV.

2.9.3.6 Stowage provisions for crew tools are noted in para 2.11.3.8. The stowage of spare parts on the test vehicles was not authorized.

2.9.3.7 The maintenance ratio for test item, Ser No 53, was 1.35 before major modification, 1.21 after, and 1.31 for the entire test. Maintenance time expended for modification of the test item is considered before major modification. The maintenance ratio for test item, Ser No 54, was 0.99. The overall maintenance ratio was 1.19 before major modification, 1.21 after, and 1.19 for the entire test.

2.9.3.8 Crew maintenance (exclusive of daily "A" services) was 1.0 man-hour per operating day (equivalent to 12-hour mission) for both test items throughout the test.

2.9.3.9 One organizational maintenance service (scheduled 0 service) required 12.9 man-hours. Removal (simulated) of the bridge from the launcher with an inoperable engine required 7.5 man-hours. The scheduled and unscheduled organizational maintenance was 0.61 man-hour per 10 launchings before major modification and 0.08 man-hour per 10 launchings after major modification for the vehicle launcher. Man-hour requirements for the bridge were 0.30 per 100 vehicle crossings before major modification and 0.72 after.

2.9.3.10 The largest single direct support maintenance service was 3.5 man-hours.

2.9.3.11 The following mean down time for maintenance action (unscheduled organizational and direct support maintenance) was experienced on two test vehicles:

a. Before modification (848 launches) = 1.61 hours
(58.0 clock-hours/36 maintenance actions)

b. After modification (175 launches) = 2.34 hours
(11.7 clock-hours/5 maintenance actions)

c. Total test (1,023 launches) = 1.70 hours
(69.7 clock-hours/41 maintenance actions)

2.9.4 Analysis

2.9.4.1 The criteria stated in para 2.9.1.2b and d were met.

2.9.4.2 The criterion stated in para 2.9.1.2a was not met.

2.9.4.3 The criterion in para 2.9.1.2c was partially met in that the man-hours expended for the vehicle launcher were within the limits only after modification. Additionally, the man-hours expended for the bridge were within limits prior to modification but exceeded the .33 man-hour per 100 vehicle crossings subsequent to modification. The remainder of the criterion in the paragraph was not met.

2.9.4.4 The criterion in para 2.9.1.2e was met.

2.10 RELIABILITY

2.10.1 Objective

2.10.1.1 To assess the reliability of the test items and derive information regarding expected service life and required logistic support.

2.10.1.2 Criteria

a. The equipment shall possess sufficient ruggedness in design to withstand military service without requiring major overhaul or replacement for 750 kilometers or 750 launching cycles.

b. The launcher and launcher conversion components for the APC vehicle shall demonstrate a mean time between failures (MTBF) of no less than 240 kilometers or 240 launches.

c. The bridge shall demonstrate an MTBF of no less than 240 launches and 3,600 crossings by a combat-loaded M113A1.

d. The inherent availability due to unscheduled maintenance for the launcher and bridge shall be no less than 92.5 percent with a mean time to repair (MTTR) of not more than 12 hours. A typical mission will be for a period of 12 hours and will consist of the following:

(1) Launches - 20.

(2) Movement to and from launch sites - 20 kilometers.

(3) Vehicle traffic per launch - 15 crossings of a combat-loaded M113A1.

e. The achieved availability due to downtime incurred for preventive and corrective maintenance shall not be less than 90 percent. A typical mission will be for a period of 12 hours and will consist of the following:

(1) Launches - 20.

(2) Movement to and from launch sites - 20 kilometers.

(3) Vehicle traffic per launch - 15 crossings of a combat-loaded M113A1.

f. The equipment shall be designed to withstand shock and vibration environments and be sufficiently rugged and robust to withstand normal field usage.

2.10.2 Method

2.10.2.1 Test items were to be continued in operation until 1,000 launch-retrieve cycles and 1,000 kilometers over paved roads, gravel roads, and off road had been performed with each test item. Even though one test item was modified, the test was terminated before these goals were reached, because of repeated failures. (See part 2, page I-6, app I for list of modifications.) The launch-retrieve cycles were interspaced as equally as possible during the kilometers of operations.

2.10.2.2

a. A record of all failures was maintained throughout the test. For the purpose of computing mean time between failures (MTBF), a failure is defined as a malfunction which cannot be compensated for by adjustment by the operator using controls normally accessible to him during routine operation, or which cannot be repaired by the crew, using on-equipment tools and parts, within 15 minutes, which causes any or all of the following:

(1) Abortion of the mission.

(2) Damage to the system by continued use.

(3) A safety hazard.

b. Simultaneous related failures were considered as one failure.

c. Malfunctions which did not affect mission performance (e.g., broken engine access grille, personnel door in rear ramp jammed closed, troop convenience items) were not considered failures.

2.10.2.3 A record of active maintenance man-hours and hours to repair failures was maintained by maintenance level throughout the test.

2.10.2.4 The overall mean time between failures (MTBF) for all test launchers and launcher conversion components was computed by adding the kilometers and launch cycles for all test launchers from the beginning of the test to the time at which the major modification was made and dividing these two sums by the total number of failures recorded for all test launchers and launcher conversion components for this period. The MTBF was again calculated in a similar manner for the one test item (Ser No 53) operated after the major modification. The kilometers and launch cycles from the major modifications to the end of the test were divided by the total number of failures recorded for this period. (Simultaneous related failures were recorded as one failure.)

2.10.2.5 The overall MTBF for the bridges was computed in the same manner as for the launchers, except crossings were substituted for kilometers.

2.10.2.6 The overall mean time to repair (MTTR) for all test launchers was computed by dividing the total active maintenance man-hours required to correct failures on all test launchers by the total number of failures recorded on all test launchers. This was computed before and after major modification.

2.10.2.7 The overall MTTR for all bridges was computed in the same manner as for the launchers.

2.10.2.8 Separate records of repair parts used throughout the test were maintained for the launcher and for the bridge.

2.10.2.9 Using the formula:

$$R = e^{-(t/2T)X^2(\alpha\ ;\ 2r+2)}$$

Where R = reliability
e = natural base of logarithms
t = number of launch cycles per mission
X^2 = chi squared
α = complement of the required confidence limit
r = number of failures during testing
T = total launch cycles during testing

The terms t and T above, which normally represent mission and test time functions, were computed in this manner to more realistically relate reliability to missions based on the number of launch cycles carried out rather than test time. The overall project reliability for all test items for 12-hour missions was predicted with 90 percent confidence (α = 0.10) for the period of testing before major modification and for the period following major modification.

2.10.3 Results

2.10.3.1 The test items were operated as follows:

Operation	Ser No 53 Hours	Ser No 53 Miles	Ser No 53 Km	Ser No 54 Hours	Ser No 54 Miles	Ser No 54 Km	Total Hours	Total Miles	Total Km
Hard-surface road	5.9	44.8	72.1	3.4	26.7	43.0	9.3	71.5	115.1
Gravel road	6.1	48.3	77.7	5.2	40.7	65.5	11.3	89.0	143.2
Launching/ Retrieving	50.0	399.3	643.0	26.5	214.0	344.6	76.5	613.3	987.6
Swimming	1.2	1.7	2.7	1.4	1.9	3.1	2.6	3.6	5.8
Total	63.2	494.1	795.5	36.5	283.3	456.2	99.7	777.4	1,251.7

2.10.3.2 The test items performed the following launches and crossings:

Launch Cycles	Ser No 53	Ser No 54	Total
Before major modification	472	376	848
After major modification	175	-	175
Total	647	376	1,023
Bridge Crossings			
Before major modification	7,080	5,640	12,720
After major modification	2,625	-	2,625
Total	9,705	5,640	15,345

2.10.3.3 The overall mean time between failures (MTBF) for all test launchers and launcher conversion components before major modification was as follows:

	Ser No 53	Ser No 54	Overall
Kilometers	574.4	456.2	1,030.6
Launch cycles	472	376	848
Number of failures*	7/7	12/13	19/20
MTBF (Km)	82.05	38.01	54.24
MTBF (Launches)	67.42	31.33	44.63

2.10.3.4 The overall mean time between failures (MTBF) for all test launchers and launcher conversion components after major modification was as follows:

	Ser No 53	Ser No 54	Overall
Kilometers	221.1	-	221.1
Launch cycles	175	-	175
Number of failures*	1/1	-	1/1
MTBF (Km)	221.1	-	221.1
MTBF (Launches)	175	-	175

2.10.3.5 The overall mean time between failures (MTBF) for all test bridges before major modification was as follows:

	Ser No 53	Ser No 54	Overall
Launches	472	376	848
Crossings	7,080	5,640	12,720
Number of failures*	11/12	6/6	17/18
MTBF (Launches)	42.90	62.66	49.88
MTBF (Crossings)	643.63	940.00	748.23

*The first figure represents the number of failures used to compute the MTBF (excludes simultaneous related failures). The second figure represents the number of all failures used to compute the MTTR.

2.10.3.6 The overall mean time between failures (MTBF) for all test bridges after major modification was as follows:

	Ser No 53	Ser No 54	Overall
Launches	175	-	175
Crossings	2,625	-	2,625
Number of failures*	2/2	-	2/2
MTBF (Launches)	87.50	-	87.50
MTBF (Crossings)	1,312.50	-	1,312.50

2.10.3.7 The overall mean time to repair (MTTR) for all test launchers and launcher conversion components before major modification was as follows:

	Ser No 53	Ser No 54	Overall
Number of failures*	7/7	12/13	19/20
Maintenance time (man-hours)	10.2	7.4	17.6
Maintenance time (clock-hours)	6.2	4.5	10.7
MTTR (man-hours)	1.45	.56	.88
MTTR (clock-hours)	.8[illegible]	.26	.53

2.10.3.8 The overall mean time to repair (MTTR) for all test launchers and launcher conversion components after major modification was as follows:

	Ser No 53	Ser No 54	Overall
Number of failures*	1/1	-	1/1
Maintenance time (man-hours)	.4	-	.4
Maintenance time (clock-hours)	.2	-	.2
MTTR (man-hours)	.4	-	.4
MTTR (clock-hours)	.2	-	.2

*The first figure represents the number of failures used to compute the MTBF (excludes simultaneous related failures). The second figure represents the number of all failures used to compute the MTTR.

2.10.3.9 The overall mean time to repair (MTTR) for all test bridges before major modification was as follows:

	Ser No 53	Ser No 54	Overall
Number of failures*	11/12	6/6	17/18
Maintenance time (man-hours)	18.3	7.5	25.8
Maintenance time (clock-hours)	10.9	4.2	15.1
MTTR (man-hours)	1.52	1.25	1.43
MTTR (clock-hours)	.90	.70	.83

2.10.3.10 The overall mean time to repair (MTTR) for all test bridges after major modification was as follows:

	Ser No 53	Ser No 54	Overall
Number of failures*	2/2	-	2/2
Maintenance time (man-hours)	19.0	-	19.0
Maintenance time (clock-hours)	10.0	-	10.0
MTTR (man-hours)	9.5	-	9.5
MTTR (clock-hours)	5.0	-	5.0

2.10.3.11 The overall mean time between failures (MTBF) for launchers and bridges and the overall mean time to repair (MTTR) for launchers and bridges from beginning of test to termination were as follows:

	Ser No 53	Ser No 54	Overall
Launches	647	376	1,023
Crossings	9,705	5,640	15,345
Kilometers	795.5	456.2	1,251.7
Number of failures (launchers)* (before modification)	7/7	12/13	19/20

*The first figure represents the number of failures used to compute the MTBF (excludes simultaneous related failures). The second figure represents the number of all failures used to compute the MTTR.

	Ser No 53	Ser No 54	Overall
Number of failures (bridges)* (before modification)	11/12	6/6	17/18
Number of failures (launchers)* (after modification)	1/1	-	1/1
Number of failures (bridges)* (after modification)	2/2	-	2/2
Maintenance time (launchers) (man-hours)	10.6	7.4	18.0
Maintenance time (launchers) (clock-hours)	6.4	4.5	10.9
Maintenance time (bridges) (man-hours)	37.3	7.5	44.8
Maintenance time (bridges) (clock-hours)	16.2	4.2	20.4
MTBF (launcher for launches)	80.87	31.33	51.15
MTBF (launcher for kilometers)	99.43	38.01	62.58
MTBF (bridge for launches)	49.76	62.66	53.84
MTBF (bridge for crossings)	746.53	940.00	807.63
MTTR (launcher) (man-hours)	1.32	.56	.85
MTTR (launcher) (clock-hours)	.80	.34	.51
MTTR (bridge) (man-hours)	2.66	1.25	2.24
MTTR (bridge) (clock-hours)	1.15	.70	1.02
MTBF (launcher and bridge) (before modification)**	25.11	20.88	23.55

*The first figure represents the number of failures used to compute the MTBF (excludes simultaneous related failures). The second figure represents the number of all failures used to compute the MTTR.

**The overall mean time between failures was computed using total launches in leiu of total test hours, in that launches relate more realistically to reliability for the test item.

	Ser No 53	Ser No 54	Overall
MTBF (launcher and bridge) (after modification)**	58.33	-	58.33
MTTR (launcher and bridge) (before modification, clock-hour)	.90	.45	.67
MTTR (launcher and bridge) (after modification, clock-hours)	3.40	-	3.40

**The overall mean time between failures was computed using total launches in lieu of total test hours, in that launches relate more realistically to reliability for the test item.

2.10.3.12 Using the formula $Ai = \frac{MTBF}{MTBF + MTTR}$, the inherent availability for the launcher and bridge was 95.3 percent before and 90 percent after major modification. Overall mean time to repair was .67 hours before and 3.40 hours after major modification.

2.10.3.13 Using the formula $Aa = \frac{MTBM}{MTBM + \bar{M}}$, the achieved availability for the launcher and bridge was 89.4 percent before and 88.4 percent after major modification. Launches were used to compute MTBM in lieu of total test time.

2.10.3.14 Using the formula:

$$R = e^{-(t/2T)X^2} \quad (\alpha ; 2r+2)$$

Where R = reliability
e = natural base of logarithms
t_2 = number of launch cycles per mission
X^2 = chi squared
α = complement of the required confidence limit = 0.10
r = number of failures during testing
T = Total launch cycles during testing

The mission reliability at 90 percent confidence level for a 12-hour mission was 35 percent before and 47 percent after major modification.

2.10.3.15 The following reliability deficiencies were encountered during test. Those considered failures are so annotated. See part

1-B, app IV, for complete listing of all failures to include accrued hours/miles or launches/crossings at failure and maintenance time to repair.

a. The link beam flanges cracked repeatedly and were modified during testing (four failures). (See para 1.1, app III and part 2, page I-6, app I.) The short duration of test, after modification, prevented thorough evaluation of modification.

b. The cylinder beam flange cracked and the beam was replaced (simultaneous related failure). (See para 1.2.1, app III.)

c. The cylinder beam bushings loosened in their aluminum seats and caused severe wear to the beam. (See para 1.2.2, app III.) Bushing spacers were installed during testing but proved inadequate as bushings continued to work loose. (See part 2, page I-6, app I.)

d. The small vertical braces near the ends of the bridge failed repeatedly at the mounts (four failures). (See para 1.3.1, app III.) All vertical braces were replaced with new modified vertical braces during testing, however, short duration of test, after modification prevented thorough evaluation of the modified braces. (See part 2, page I-6, app I.)

e. The vertical brace near the center of the bridge failed when struck by the folding cylinder. (See para 1.3.2, app III.)

f. The hydraulic reservoirs failed by weld rupture (two failures). (See para 3.1, app III.) Repairs were attempted without success and the reservoirs were replaced with modified items. The modified reservoirs proved to be satisfactory in that no further failures were experienced. (See part 2, page I-6, app I.)

g. A cotter pin securing the hydraulic handle lever pin came out rendering the controls inoperative. (See para 1.5, app III.)

h. A tensile link failed at the bushings on the link beam due to tension (one failure). (See para 1.6, app III.) Part was modified, but was not installed before termination of the test.

i. The hose retractors failed repeatedly and were replaced with modified items (five failures). (See para 1.8, app III and part 2, page I-6, app I.) The short duration of test, after modification, prevented thorough evaluation of modification.

j. The hydraulic control handles (folding and launch) failed repeatedly at the locknuts. Repairs were attempted without

success and all handles were modified. (See para 1.9.1 and 1.9.2, app III and part 2, page I-6, app I.) A launch handle failure was experienced after modification. (Five failures occurred before modification and one after modification.) The modification to the launch control handle was considered inadequate. The folding control handle modification was not fully evaluated due to test termination.

k. The hydraulic pump and/or hydraulic system failed making recovery of the bridge impossible (two failures). (See para 1.10 and 1.14, app III.) The pump was modified by the manufacturer, however, test termination prevented thorough evaluation of the modified pump. (See part 2, page I-6, app I.)

m. The link beam mounts on the ramp sections failed on several occasions (two failures). (See para 1.11, app III.) Difficulty was experienced with welding instructions and the mounts were finally repaired after all testing was terminated.

n. A launching cylinder failed with a severe leak (one failure). (See para 1.12.2, app III.)

o. The rotating beam retaining bolts failed repeatedly from shear stress (six failures). (See para 1.13, app III.) The bolts, rotating beam, and rotating beam pins were all modified in an attempt to correct the problem, however, test termination prevented thorough evaluation of modification. (See part 2, page I-6, app I.)

p. The sliding link failed at the clevis pin (one failure). (See para 1.15, app III.) It was repaired by welding.

2.10.3.16 The following reliability shortcomings were experienced during the test. Those considered to be failures are so annotated.

a. Ramp guide plate for the locking pins broke and was welded. (See para 2.1.2, app III.)

b. Nonskid ramp coating peeled off. (See para 2.1.3, app III.)

c. Gouged locking pins. (See para 2.2.1, app III.)

d. Loose locking pins. (See para 2.2.2, app III.)

e. Loose quick-disconnect fittings and clamps. (See para 2.3, app III.)

f. Vehicle hand throttle control broke. (See para 2.4, app III.)

g. Weld on the nose of the tongue assembly frame developed a crack and was rewelded. (See para 2.5, app III.)

h. Hydraulic reservoir drain valve developed a small leak. (See para 2.6.1, app III.)

i. Misaligned rotating beam link arms caused cotter pins at the clevis pin to shear. (See para 2.7, app III.) Cotter pins were replaced with modified clevis pins. (See part 2, page I-6, app I.)

j. A hose retractor beam failed (one simultaneous related failure). (See para 2.8, app III.) The beam was modified during testing, however, test termination prevented thorough evaluation of modification. (See part 2, page I-6, app I.)

k. The retainer plates (launching beam) and set screws loosened repeatedly. (See para 2.10, app III.)

m. Launch cylinder developed a leak. (See para 2.12, app III.)

n. The hydraulic pump control assembly failed at the threaded end of the cable and at the cotter pin of the yoke-cable connection. (See para 2.13, app III.)

o. The folding cylinder clevis loosened at the threaded piston rod. (See para 2.14, app III.)

2.10.3.17 Repair parts used during the test are listed in part 2-B, app IV.

2.10.4 Analysis

2.10.4.1 The criterion stated in para 2.10.1.2a was considered not met because major modifications were required before either goal of 750 kilometers or 750 launches was achieved. Additionally, the criteria in para 2.10.1.2b, c, e, and f were not met.

2.10.4.2 The criteria in para 2.10.1.2d was partially met in that inherent availability was sufficient prior to modification but was insufficient subsequent to modification. The MTTR portion of the criteria was also met.

2.10.4.3 Of all the deficiencies noted in para 2.10.3.15 only the hydraulic reservoir was considered corrected. The vertical braces are not considered to be fully evaluated because the modified hose

retractor beams change the loads on the bridge ramps and testing was terminated shortly after this modification. The modified hydraulic handles are not considered corrected because of a subsequent failure. The addition of bushing spacers in no way corrects the basic problem of the bushings loosening and wearing the aluminum member. All other modifications were not tested sufficiently to evaluate.

2.11 HUMAN FACTORS ENGINEERING

2.11.1 Objectives

2.11.1.1 To determine whether the test item is suitable with respect to safety and compatible with the skills, aptitudes, and limitations of personnel who will operate and service it.

2.11.1.2 To determine the driver's and operator's visual limitations to the side, front, rear, and overhead.

2.11.1.3 Criterion. The equipment shall have simple, easily accessible controls so that the bridge can be launched or recovered by a three-man crew (two-man crew desirable).

2.11.2 Method

Throughout all testing, observations were made with respect to, and crew members were instructed to report, difficulties experienced in operation of the vehicles to include visual limitations, discomforts suffered, safety hazards encountered, and areas where improvements may be made.

2.11.3 Results

2.11.3.1 See para 2.5.3.7 for safety considerations with respect to crew evacuation during swimming.

2.11.3.2 The bridge in wet or muddy conditions presents a safety hazard to personnel in trafficking vehicles. (See para 2.8.3.2b.) Several times during the test a crossing M113A1 slipped off the bridge in mid-span. In these cases one track would slip off the outside edge of the ramp and the vehicle would come to rest on its belly with the other track on the bridge roadway.

2.11.3.3 Attachment of the hydraulic connections for the bridge recovery is a discomfort and possible hazard to the third crewman (outside man). The quick disconnect plug valves must be depressed to release hydraulic pressure before connection is possible. During

the test, hydraulic fluid sprayed on personnel during this operation and caused some eye irritation.

2.11.3.4 Two persons were struck on the head by the cargo hatch cover during launch operations. The bridge seat prevents the cover from being locked open.

2.11.3.5 Mud, rocks, and other debris fall on the driver and commander/operator during bridge recovery.

2.11.3.6 The driver's hatch cover cannot be fully opened with the bridge in the travel position. Conversely, the cover cannot be closed if it is locked open. The vehicle must be started and the bridge raised several inches to free the hatch cover.

2.11.3.7 The commander/operator's hatch cover can only be locked open to the front or rear when the bridge is in the travel position. Also, the cupola cannot be rotated 360° when the hatch is open.

2.11.3.8 Items (i.e., crew tools) stowed on the roof of the APC are not readily accessible.

2.11.3.9 Driver and commander/operator visibility is limited slightly to the front of the vehicle by the surfboards and the launch assembly linkage. Overhead visibility is limited severely at both stations by the bridge in the travel position. Commander/operator visibility to the sides and rear is not materially affected. Driver visibility to the sides is limited by the launching beams in the travel position.

2.11.3.10 The controls are easily accessible so that the bridge can be launched with a two-man crew. However, testing indicated that a three-man crew is necessary for recovery of the bridge.

2.11.3.11 One modification was made during testing to reduce a safety hazard. (See [illegible]t 2, page I-6, app I.) A locking device was installed on the locking pin control lever. This reduces the possibility of the bridge falling on the vehicle as a result of the operator accidentally disengaging the locking pins during launch or recovery. No such incident was encountered during testing.

2.11.4 Analysis

2.11.4.1 The criterion stated in para 2.11.1.3 was met.

2.11.4.2 All personnel should be thoroughly oriented on the potential hazards of trafficking and the limitations on the use of the hatches.

2.12 TRAINING

2.12.1 Objective

To determine the adequacy of current military occupational specialties (MOS) with respect to the operation and maintenance of the test vehicle.

2.12.2 Method

Throughout all testing, operation and maintenance procedures carried out by test personnel on the test vehicles were evaluated against the skills and knowledge required by military occupational specialty of the personnel who will normally be assigned to operate and maintain the units.

2.12.3 Results

2.12.3.1 No additional training beyond the scope of MOS 11E (armor crewman) was necessary for operating personnel.

2.12.3.2 No additional training was necessary for organizational and direct support maintenance personnel.

2.12.4 Analysis

Not applicable.

2.13 TOOLS AND TEST EQUIPMENT

2.13.1 Objective

To determine whether appropriate common and special tools and test equipment are suitable for the intended purpose and maintenance level.

2.13.2 Method

Adequacy of operator/crew maintenance tools, organizational maintenance tools, and field maintenance tools, including components of special tools and equipment sets for the M113A1 vehicle was checked. No special tools were furnished specially for the test item. The maintenance operations for which special tools and equipment were intended were evaluated. The feasibility of substituting common tools for special tools was investigated.

2.13.3 Results

2.13.3.1 Operator/crew tools were not adequate to remove accumulated mud in a reasonable time from the bridge deck to enable the launcher to retrieve the bridge.

2.13.3.2 Organizational and field maintenance common tools, and the special tools and equipment provided for the M113A1 vehicle were adequate for support of the test item.

2.13.3.3 A pressure gage was required at the direct support maintenance level to perform the checks and adjustments of the launcher hydraulic pressure system. This pressure gage (FSN 6685-581-5186) listed in the basic issue items list in DTM 5-5420-206-15 (dated Jun 68) was not furnished with the test items. Other stock gages, available at this board, were used without satisfaction. Near the end of test a pressure gage (FSN 6685-774-4761) was furnished and performed the hydraulic pressure checks satisfactorily. (See para 3.2, app III.)

2.13.4 Analysis

Not applicable.

2.14 TECHNICAL MANUSCRIPTS AND MANUALS

2.14.1 Objective

2.14.1.1 To determine whether the equipment publications are adequate for the intended maintenance level.

2.14.1.2 Criterion. Lifting and tiedown instructions for air, rail, and water shipment shall be provided.

2.14.2 Method

2.14.2.1 The equipment publications for the test item were checked for accuracy and adequacy.

2.14.2.2 The equipment serviceability criteria were not received.

2.14.3 Results

DTM 5-5420-206-15, Operator and Organizational, Direct and General Support and Depot Maintenance Manual Including Repair Parts List for Launcher M113, June 1968, w Supplement Number 1,

June 1968, was received in six copies on 13 Aug 68, and was considered inadequate. (See para 2.15, app III.) Following are examples of manual discrepancies:

2.14.3.1 No lifting and tiedown instructions were provided for air, rail, and water shipment.

2.14.3.2 Five maintenance functions were not assigned to a maintenance level in the maintenance allocation chart and one was assigned to an inappropriate maintenance level.

2.14.3.3 Numerous repair parts were listed without federal stock numbers and many were listed only by noun nomenclature.

2.14.3.4 The monthly preventive maintenance (PM) checks and services prescribed for the test item were not consistent with the PM services prescribed for the M113 series vehicles and for the AVLB M60 series tanks. (See TM 5-5420-202-20, Jan 68.)

2.14.3.5 A legend to identify components of the hydraulic system was inadequate for figure 1-6(2), illustration of Launcher Hydraulic Components.

2.14.3.6 Four repair parts were not listed in the repair parts list.

2.14.3.7 In other incidents, instructions were incomplete, incorrect or omitted.

2.14.4 Analysis

The criterion stated in para 2.14.1.2 was not met.

APPENDIX I. TEST DATA

		PAGE
PART I	PHOTOGRAPHS	I-2
PART 2	MODIFICATIONS	I-6
PART 3	MAINTENANCE	I-7
	3.1 OPERATOR/CREW MAINTENANCE	I-7
	3.2 ORGANIZATIONAL MAINTENANCE	I-8
	3.3 DIRECT SUPPORT MAINTENANCE	I-9
	3.4 MAINTENANCE SUMMARY	I-10

PART I. PHOTOGRAPHS

US ARMY ARMOR AND ENGINEER BOARD FORT KNOX, KY	USATECOM PROJ NO 7-8-1018-06 PHOTO NO 68-755A

MARGINAL TERRAIN ASSAULT BRIDGE WITH
M113A1 LAUNCHER - TRAVEL CONFIGURATION

ARROW INDICATES SURFBOARD

US ARMY ARMOR AND ENGINEER BOARD FORT KNOX, KY	USATECOM PROJ NO 7-8-1018-06 PHOTO NO 5-2-28B

MARGINAL TERRAIN ASSAULT BRIDGE WITH
M113A1 LAUNCHER - LAUNCHING

US ARMY ARMOR AND ENGINEER BOARD FORT KNOX, KY	USATECOM PROJ NO 7-8-1018-06 PHOTO NO 69-72B

MARGINAL TERRAIN ASSAULT BRIDGE WITH
M113A1 LAUNCHER - LAUNCHER TRAFFICKING BRIDGE

US ARMY ARMOR AND ENGINEER BOARD FORT KNOX, KY	USATECOM PROJ NO 7-8-1018-06 PHOTO NO 68-755E

MARGINAL TERRAIN ASSAULT BRIDGE WITH
M113A1 LAUNCHER - SWIMMING

PART 2. MODIFICATIONS

Part Modified	FSN	No of Launchers Prior to Modification	
		53	54
Hydraulic reservoirs	- -	80	11
Vertical braces	5420-880-2639	222	70
Vertical braces	5420-880-2646	222	70
Link beams	5420-880-2783	445	349
Hydraulic handles	- -	456	376
Locking device for locking pin	- -	456	376
*Rotating beam	5420-880-2672	472	- -
*Rotating beam pins	5420-880-2717	472	- -
*Hinge pins	5420-880-2710	472	- -
*Link and cylinder beam pins	5420-880-2662	472	- -
*Clevis pin	5420-880-2665	472	- -
*Beam bushing spacers	- -	472	- -
*Hose retractors	- -	472	- -
*Hose retractor beams	- -	472	- -
*Hydraulic pump	5420-880-2882	472	- -
*Retaining bolts, (rotating beam)	- -	472	- -
*Surfboard mount	- -	472	- -

*Denotes part of major modification

PART 3. MAINTENANCE

3.1 Operator/Crew Maintenance - Unscheduled

Component:	Test Item Ser No 53		Test Item Ser No 54	
	Man-hours	Clock-hours	Man-hours	Clock-hours
Launcher				
Strainers, Filters, Hose, Pipe Fittings, Tubing, etc.	0.2	0.2	0.2	0.2
Hydraulic Cylinders	0.1	0.1	0.1	0.1
Hydraulic Controls and/or Manual Control Arms, Levers, Knobs, Linkages	0.2	0.2	-	-
Total (Launcher)	0.5	0.5	0.3	0.3
Bridge				
Bridge Launching and Retrieving Components	0.2	0.1	-	-
Bridging Equipment	0.5	0.3	-	-
Hydraulic Cylinders	0.2	0.2	-	-
Total (Bridge)	0.9	0.6		
Total (Op/Crew Unsched)	1.4	1.1	0.3	0.3

The operator/crew maintenance shown above is a part of the 1.0 man-hour expended per operating day.

3.2 Organizational Maintenance

3.2.1 Scheduled Service	Test Item Ser No 53		Test Item Ser No 54	
Component:	Man-hours	Clock-hours	Man-hours	Clock-hours
Vehicle	9.9	9.5	-	-
Launcher	1.6	0.8	-	-
Bridge	1.4	0.7	-	-
Total for one Q-Service	12.9	11.0		

3.2.2 Unscheduled Maintenance

Component:				
Vehicle				
Mounts, Hull Bushings (Surfboards)	0.2	0.1	2.5	1.5
Launcher				
Bridge Launching and Retrieving Components	3.6	3.6	0.2	0.2
Strainers, Filters, Hose, Pipe Fittings, Tubing, etc.	1.5	1.0	-	-
Pump and Pump Drives	4.0	2.0	-	-
Manifold and/or Control Valve	3.3	1.7	16.2	12.6
Hydraulic Cylinders	-	-	0.5	0.3
Liquid Tank or Reservior	4.0	2.0	4.0	2.0
Hydraulic Controls and/or Manual Control Arms, Levers, Knobs, Linkages	1.4	1.2	0.3	0.3
Total (Vehicle/Launcher)	18.0	11.6	23.7	16.9

	Test Item Ser No 53		Test Item Ser No 54	
	Man-hours	Clock-hours	Man-hours	Clock-hours
Bridge				
Bridge Launching and Retrieving Components	-	-	1.5	0.7
Bridging Equipment	44.1	26.9	10.1	6.9
Total (Bridge)	44.1	26.9	11.6	7.6
Total (Org)	62.1	38.5	35.3	24.5
3.3 Direct Support Maintenance				
Component:				
Launcher				
Bridge Launching and Retrieving Components	-	-	1.0	1.0
Manifold and/or Control Valve	5.0	3.0	-	-
Hydraulic Controls and/or Manual Control Arms, Levers, Knobs, Linkages	1.7	1.7	-	-
Total (Vehicle/Launcher)	6.7	4.7	1.0	1.0
Bridge				
Bridge Launching and Retrieving Components	1.0	1.0	-	-
Total (DS)	7.7	5.7	1.0	1.0

3.4 Maintenance Summary

	Test Item Ser No 53		Test Item Ser No 54
	Before Modification	After Modification	
Total op/crew, man-hours	[illegible]	8.5	18.0
Total org man-hours on veh/launcher	28.1	1.4	23.7
Total org man-hours on bridge	26.5	19.0	11.6
Total org man-hours	54.6	20.4	35.3
Total direct support man-hours	5.2	2.5	1.0
Total unscheduled down time, clock-hours	32.5	11.7	25.5
Total down time, clock-hours	43.5	11.7	25.5

APPENDIX II. FINDINGS

The following shows the extent to which the test item met the applicable requirements extracted from the Small Development Requirement as changed by references 7, 8, and 9, appendix V.

	REQUIREMENTS	DEGREE OF ACHIEVEMENT			REMARKS
		Met	Fell Short	Not Determined	
1.	The weight of launcher and bridge in travel position will not exceed the weight of the combat-loaded current APC.		X		See para 2.2.3.1 and para 2.2.4.1. Weight of test item exceeds weight of M113A1 by 1,900 pounds.
2.	The launcher (vehicle and mechanism) with bridge in travel position will have as low a profile as possible but not to exceed a height of 12 feet.	X			See para 2.2.3.2.
3.	The test vehicle will have mobility equivalent to the standard M113, except as affected by the changed center of gravity location resulting from the bridge/launcher mounting.			X	Not tested completely. See para 2.3.3, 2.3.4, 2.4.3, and 2.4.4.
4.	The swimming characteristics of the test item with bridge in travel position will equal that of the standard M113 except as affected by the changed center of gravity location resulting from the bridge/launcher mounting.		X		See para 2.5.3.7. Crew evacuation in event of sinking considered inadequate.

	REQUIREMENTS	DEGREE OF ACHIEVEMENT			REMARKS
		Met	Fell Short	Not Determined	
5.	The test vehicle will be provided with connections permitting it to be towed and to tow equivalent to the current APC.			X	See para 2.6.4. The test item could be towed. Termination of test prevented testing the item for towing capabilities.
6.	Launcher must operate utilizing standard Army fuel and lubricants.	X			See para 2.7.3.1.
7.	Equipment must have sufficient fuel capacity for a distance traveled equal to the current APC.			X	Not tested due to test termination. See para 2.7.4.2.
8.	The bridge shall be capable of spanning gaps up to and including 33 feet.	X			See para 2.8.3.1.
9.	The bridge shall be capable of sustaining all standard military vehicles up to and including a combat loaded M113A1.	X			See para 2.8.3.2.
10.	The bridge shall be capable of being launched and retrieved on sites when:				
	a. The launcher is positioned on an 8-percent side slope.			X	Not tested due to test termination. See para 2.8.2.1.

REQUIREMENTS	DEGREE OF ACHIEVEMENT			REMARKS
	Met	Fell Short	Not Determined	
b. The slope between the launching plane and the far shore is as large as plus 15 percent or minus 10 percent.			X	Not tested due to test termination. See para 2.8.2.1.
11. The bridge shall be capable of being emplaced without site improvement.	X			See para 2.8.3.3.
12. The equipment will be capable of launching the bridge without exposing the crew while providing armor protection equivalent to the current M113 APC.		X		See para 2.8.3.4. Head and shoulders of two crew members must be exposed to emplace bridge.
13. The bridge shall be capable of being recovered from either bank by the launching vehicle.	X			See para 2.5.2.6.
14. The bridge will be capable of immediate use after launch.	X			See para 2.8.3.10.
15. The equipment will be capable of launching and recovery of the bridge in the folded or travel position for ease of transport operations.			X	Not tested due to test termination. See para 2.8.4.3.
16. The turnaround time shall not exceed 30 minutes (20 minutes desired), assuming no repairs are necessary. This is the time required to service and check out the material for recommitment, beginning from engine shutdown to restarting the engine.	X			See para 2.8.3.5.

REQUIREMENTS	DEGREE OF ACHIEVEMENT			REMARKS
	Met	Fell Short	Not Determined	
17. Reaction Time.				
a. The vehicle reaction time shall not exceed 2 minutes in the intermediate zone. This is the time required for the operator, in position to start the engine and move the launcher with the bridge in travel position.	X			See para 2.8.3.6.
b. The time required for the bridge to be launched once the launcher is at the gap site is 3 minutes. This interval includes the time to emplace the bridge and back the launcher away to allow other vehicles to pass.	X			See para 2.8.3.7.
c. The time for the launcher to remount the bridge into travel position shall not exceed 10 minutes in the intermediate zone. (This includes connection of hydraulic components as required.)	X			See para 2.8.3.8.
18. The APC (MTAB) shall have the following maintenance characteristics:				

REQUIREMENTS	DEGREE OF ACHIEVEMENT			REMARKS
	Met	Fell Short	Not Determined	
a. The launcher shall possess the maintenance characteristics of the current APC. The installation of the launcher equipment will not significantly increase the practicable time, degree of skill, or variety of tools required for maintenance.		X		See para 2.9.3.3 and 2.9.4.2.
b. Crew maintenance shall not average more than 1.0 man-hour per 12-hour mission (exclusive of daily "A" services). (Crew maintenance limited to cleaning, minor lubrication, adjustments, replacement of modules and minor components.)	X			See para 2.9.3.8.
c. Unit (organizational) maintenance services performed shall not exceed 4.5 man-hours per maintenance action, including diagnostic time. Scheduled and unscheduled organizational maintenance (excluding operator/crew daily services) shall not exceed .25 man-hour per hour of operation or 10 launchings for the vehicle/launcher. Man-hour requirements for the bridge shall not exceed .33 per 100 vehicle crossings. (Unit (organizational) maintenance limited to minor adjustments of components and replacement of assemblies.)				Partially met. See para 2.9.3.9 and 2.9.4.3.

REQUIREMENTS	DEGREE OF ACHIEVEMENT			REMARKS
	Met	Fell Short	Not Determined	
d. Direct support maintenance services performed shall not exceed 12 hours for diagnosis and repair per maintenance action. (Direct support maintenance performed will include technical inspection and support assistance to units by contact teams in the repair or replacement of components, assemblies, and parts.)	X			See para 2.9.3.10.
19. The mean down time per 1,000 miles or 500 launches shall not exceed 2.0 hours for all unscheduled organizational and direct support maintenance.	X			See para 2.9.3.11.
20. The equipment shall possess sufficient ruggedness in design to withstand military service without requiring major overhaul or replacement for 750 kilometers or 750 launching cycles.		X		See para 2.10.4.1. Item required major modification at 472 launch cycles.
21. The launcher and launcher conversion components for the APC vehicle shall demonstrate a mean time between failures (MTBF) of no less than 240 kilometers or 240 launches.		X		The MTBF before modification was 54.24 (Km) and 44.63 (launches) and after modification was 221.1 (Km) and 175 (launches). See para 2.10.3.3 and 2.10.3.4.

REQUIREMENTS	DEGREE OF ACHIEVEMENT			REMARKS
	Met	Fell Short	Not Determined	
22. The bridge shall demonstrate an MTBF of no less that 240 launches and 3,600 crossings by a combat loaded APC.		X		The MTBF before modification was 49.88 (launches) and 748.23 (crossings) and after modification was 87.50 (launchings) and 1,312.50 (crossings). See para 2.10.3.5, and 2.10.3.6.
23. The inherent availability due to unscheduled maintenance for the launcher and bridge shall be no less than 92.5 percent with a mean time to repair (MTTR) of not more than 12 hours. A typical mission will be for a period of 12 hours and will consist of the following: a. Launches - 20 b. Movement to and from launch sites - 20 kilometers. c. Vehicle traffic per launch - 15 crossings of a combat-loaded M113A1.				Partially met. See para 2.10.3.12.
24. The achieved availability due to downtime incurred for preventive and corrective maintenance shall not be less than 90 percent. A typical mission will be for a period of 12 hours and will consist of the following:		X		The achieved availability before modification was 89.4 percent and 88.4 percent after modification. See para 2.10.3.13.

REQUIREMENTS	DEGREE OF ACHIEVEMENT			REMARKS
	Met	Fell Short	Not Determined	
a. Launches - 20				
b. Movement to and from launch sites - 20 kilometers.				
c. Vehicle traffic per launch - 15 crossings of a combat-loaded M113A1.				
25. The equipment shall be designed to withstand shock and vibration environments and be sufficiently rugged and robust to withstand normal field usage.		X		See para 2.10.3.15 and 2.10.3.16.
26. The equipment shall have simple, easily accessible controls so that the bridge can be launched or recovered by a three-man crew (two-man crew desirable).	X			See para 2.11.3.10.
27. Lifting and tiedown instructions for air, rail, and water shipments shall be provided.		X		See para 2.14.3.1. No instructions provided with items.

APPENDIX III. DEFICIENCIES AND SHORTCOMINGS

1. DEFICIENCIES

	Deficiency	Suggested Corrective Action	Remarks
1.1	Link beam flanges cracked.	None	See EPR No KD-16, KD-19 (16-2), KD-40(16-3), KD-86(16-4), and para 2.10.3.15a.
1.2	Cylinder Beam		
1.2.1	Cylinder beam flange cracked.	None	See EPR No KD-17 and para 2.10.3.15b.
1.2.2	The bushings loosened in the aluminum seats.	None	See EPR No KD-93, KD-94 (93-2), and para 2.10.3.15c.
1.3	Vertical Braces		
1.3.1	Small vertical braces failed at the mounts.	None	See EPR No KD-18, KD-41 (18-2), KD-46(18-3), KD-50(18-4), and para 2.10.3.15d.
1.3.2	Large vertical brace failed when struck by folding cylinder.	None	See EPR No KD-71 and para 2.10.3.15e.
1.4	Not used.		
1.5	Cotter pin securing the hydraulic handles failed.	None	See EPR No KD-27 and para 2.10.3.15g.

	Deficiency	Suggested Corrective Action	Remarks
1.6	Tensile link failed.	None	See EPR No KD-55 and para 2.10.3.15h.
1.7	Lower surfboard (right) mount sheared at the welds.	None	See EPR No KD-57(58-3) and para 2.5.3.1.
1.8	Hose retractors failed.	None	See EPR No KD-58, KD-72 (58-2), KD-76(58-3), KD-82(58-4), KD-90(58-5), and para 2.10.3.15i.
1.9	Hydraulic Handles		
1.9.1	Launch handles failed.	None	See EPR No KD-60, KD-63 (60-2), KD-84(60-4), KD-85 (60-5), KD-107(60-7), and para 2.10.3.15j.
1.9.2	Folding handles failed.	None	See EPR No KD-79(60-3), KD-88(60-6), and para 2.10.3.15j.
1.10	Hydraulic pump failed.	None	See EPR No KD-66 and para 2.10.3.15k.
1.11	Link beam mounts failed.	None	See EPR No KD-67, KD-110 (67-2), and para 2.10.3.15m.
1.12	Launching Cylinder		
1.12.1	Cylinder required adjustment.	None	See EPR No KD-1 and para 2.2.3.4.

	Deficiency	Suggested Corrective Action	Remarks
1.12.2	Cylinder failed.	None	See EPR No. KD-70 and para 2.10.3.15n.
1.13	Rotating beam retaining bolts failed.	None	See EPR No KD-80, KD-81(80-2), KD-89(80-3), KD-91(80-4), KD-99(80-5), KD-100(80-6), and para 2.10.3.15o.
1.14	Hydraulic system failed.	None	See EPR No KD-98 and para 2.10.3.15k.
1.15	Sliding link failed.	None	See EPR No. KD-106 and para 2.10.3.15p.
1.16	Inadequate crew evacuation facilities during swimming operations.	None	No EPR submitted. See para 2.5.3.7.

2. SHORTCOMINGS

	Shortcoming	Suggested Corrective Action	Remarks
2.1	Ramp Sections		
2.1.1	Cracked cross web was found during preoperational inspection.	None	See EPR No KD-2 and para 2.2.3.3.
2.1.2	Locking pin guide plate was broken.	None	See EPR No KD-5 and para 2.10.3.16a.
2.1.3	Nonskid coating peeled off.	None	See EPR No KD-31 and para 2.10.3.16b.

	Shortcoming	Suggested Corrective Action	Remarks
2.2	Locking Pins		
2.2.1	Locking pins were gouged.	None	See EPR No KD-6, KD-13(6-2), and para 2.10.3.16c.
2.2.2	Locking pins were loose on the piston rod.	None	See EPR No KD-32(6-3), KD-33(6-4), and para 2.10.3.16d.
2.3	Quick-disconnects		
2.3.1	Quick-disconnect fitting loosened.	None	See EPR No KD-9 and para 2.10.3.16e.
2.3.2	Female quick-disconnect clamp loosened.	None	See EPR No KD-42(9-2) and para 2.10.3.16e.
2.4	Vehicle hand throttle failed.	None	See EPR No KD-10 and para 2.10.3.16f.
2.5	Weld crack developed in the nose of the tongue assembly frame.	None	See EPR No KD-20 and para 2.10.3.16g.
2.6	Hydraulic Reservoir		
2.6.1	Reservoir drain valve leaked.	None	See EPR No KD-21 and para 2.10.3.16h.
2.6.2	Hydraulic pump mount hole had to be enlarged on a replacement reservoir.	None	See EPR No KD-49 and para 2.9.3.5.
2.6.3	Reservoir drain hole was not opened at the manufacturer.	None	See para 2.9.3.5. No EPR submitted.

	Shortcoming	Suggested Corrective Action	Remarks
2.7	Misalignment of rotating beam link arms caused cotter pins to shear.	None	See EPR No KD-39, KD-47(39-2), KD-92(39-3), and para 2.10.3.16i.
2.8	Hose retractor beam failed.	None	See EPR No KD-48 and para 2.10.3.16j.
2.9	Lower surfboard (right) retainer pin broke.	None	See EPR No KD-54 (52-2) and para 2.5.3.1.
2.10	Retainer plate set screws loosened.	None	See EPR No KD-59, KD-73 (59-2), and para 2.10.3.16k.
2.11	Hydraulic system would not lift (retreive) the bridge with approximately 400 pounds of mud on the bridge.	None	See EPR No KD-61 and para 2.8.3.9.
2.12	Launch cylinder leaked.	None	See EPR No KD-62 and para 2.10.3.16m.
2.13	Hydraulic Pump Controls		
2.13.1	Pump control cable failed.	None	See EPR No KD-96 and para 2.10.3.16n.
2.13.2	Cotter pin failed at the yoke-cable connection.	None	See EPR No KD-111 and para 2.10.3.16n.
2.14	Folding cylinder clevis loosened.	None	See EPR No KD-109 and para 2.10.3.16o.

	Shortcoming	Suggested Corrective Action	Remarks
2.15	Discrepancies in DTM 5-5420-206-15; Operator and Organizational, Direct and General Support and Depot Maintenance manual including Repair Parts List for Launcher M113, June 1968, require correction.	Changes were submitted on DA Form 1598 to Commanding General, US Army Mobility Equipment Command, ATTN: AMSME-QRT.	See EPR No KD-1 through KD-8 (all Pubs) and para 2.14.3.

3. CORRECTED DEFICIENCIES/SHORTCOMINGS

	Deficiency/Shortcoming	Corrective Action	Remarks
3.1	Hydraulic reservoirs failed.	A modified reservoir provided during test.	See EPR No KD-3, KD-15 (3-2), KD-22(3-3), KD-28 (3-4), and para 2.10.3.15f.
3.2	Specified hydraulic pressure gauge (FSN 6685-581-5186) was not provided.	Pressure gauge (FSN 6685-774-4761) was provided by USAMERDC and found to be satisfactory.	See EPR No KD-101, KD-101s, and para 2.13.3.3.

APPENDIX IV. MAINTENANCE EVALUATION

TABLE OF CONTENTS

		PAGE
PART 1	MAINTENANCE AND RELIABILITY ANALYSIS CHARTS	
	1-A INSTRUCTIONS	IV-2
	1-B DATA (ACTUAL OPERATIONS)	IV-4
	1-C DATA (SIMULATED OPERATIONS)	IV-15
PART 2	PARTS ANALYSIS CHARTS	
	2-A INSTRUCTIONS	IV-17
	2-B DATA	IV-18

PART 1-A

MAINTENANCE AND RELIABILITY ANALYSIS CHART INSTRUCTION SHEET

COLUMN	DESCRIPTION
1	Group number as indicated in the Maintenance Allocation Chart. The sequence in which the maintenance operation was performed is indicated in parenthesis.
2	Components and related operations as indicated in the Maintenance Allocation Chart. Operations indicated as in Depot Category are not shown.
3	Maintenance Level, Prescribed. Category prescribed by the Maintenance Allocation Chart is indicated by the letters C, O, F, or H. C - Operator or Crew; O - Organizational, F - Direct Support; H - General Support.
4	Maintenance Level, Recommended. Category recommended by the test agency.
5	TM Instructions, Adequate. An X in this column indicated the TM instructions are considered adequate. NA indicates no instructions were deemed necessary.
6	TM Instructions, Inadequate. The test agency EPR number is indicated in this column, if the instructions are considered inadequate.
7	Active Maintenance Time. The man-hours and clock-hours of active maintenance time to the closest tenth are shown. Prefix "E" indicates time was estimated.
8	System Life. Number of miles and hours accumulated by the system before this operation was performed. The sequence number for which the particular operation was last performed is shown in parenthesis. An "S" is shown in this column if the operation was performed on a sampling basis and not because of an actual failure.

COLUMN	DESCRIPTION
9	Reason performed. The symbol "Unsched" is shown in this column if the operation was performed as a result of unscheduled maintenance. If the operation was performed as a result of scheduled maintenance, it is indicated by the symbol "Sched". If the operation was performed only to verify procedures not as a result of breakdown, it is indicated by the symbol "Sim".
10	Remarks. If an EPR was related to a maintenance operation, the EPR number is indicated. The notation "failure" indicates operations performed as a result of a failure. If the operation was not performed as a result of using the sampling technique authorized by AR 750-6, one of the following remarks is entered as appropriate. a. Reviewed - not performed. b. Neither reviewed nor performed due to (NO TMS) or (insufficient service test time). c. Other as appropriate.

PART 1-B. DATA (ACTUAL OPERATIONS)

MAINTENANCE AND RELIABILITY ANALYSIS CHART	PROJECT NO. 7-8-1018-06	NOMENCLATURE Marginal Terrain Assault Bridge with M113A1 Launcher	IDENTIFICATION NO. Serial Number 53

GF NO.	COMPONENT AND RELATED OPERATIONS	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL		TM INSTRUCTIONS		ACTIVE MAINT TIME	SYSTEM LIFE M-MILES H-HOURS R-ROUNDS	REASON PERFORMED	REMARKS
		PRESB	RECM	ADQT	INADQT				
1	2	3	4	5	6	7	8	9	10
4308 (1)	Replaced: Reservoir, Hydraulic	0	0	X		4.0-MH 2.0-CH	47.8-M 1.2-H	Unsched	Failure. See EPR no KD-15(3-2) and KD-49. Launches-80; crossings - 1,200
1508 (2)	Replaced: Bracing Cross Beams, etc. (Link Beam)	0	0	X		1.9-MH 0.9-CH	51.0-M 7.8-H	Unsched	Failure. See EPR No KD-16. Launches-80; crossings 1,200
1508 (3)	Replaced: Bracing Cross Beams, etc. (Cylinder Beam)	0	0	X		1.5-MH 0.7-CH	51.0-M 7.8-H	Unsched	Failure. See EPR No KD-17. Simultaneous related failure. Launches-80; crossings - 1,200
1508 (4)	Replaced: Bracing Cross Beam, etc. (Link Beam)	0	0	X		1.9-MH 0.9-CH	51.0-M 7.8-H	Unsched	Failure. See EPR No KD-40(16-3). Launches-80; crossings-1,200
1508 (5)	Replaced: Bracing Cross Beam, etc. (Beam Rotating)	0	0	X		1.6-MH 1.6-CH	160.7-M 18.2-H	Unsched	Launches - 215; crossings - 3,225
1508 (6)	Replaced: Bracing Cross Beam, etc. (Brace Vertical)	0	0	X		1.5-MH 1.5-CH	160.7-M 18.2-H	Unsched	Failure. See EPR No KD-50(18-4). Launches-215; crossings - 3,225
4301 (7)	Replaced: Fittings and Quick-Disconnects	0	0	X		0.5-MH 0.5-CH	172.2-M 19.3-H	Unsched	Launches - 222; crossings - 3,330
1505 (8)	Adjusted: Launching Assembly. (Retainer Plate)	Not Presb	0		EPR No KD-7 (Pub)	0.4-MH 0.4-CH	206.6-M 23.1-H	Unsched	See EPR No KD-59. Launches - 270; crossings 4,060

MAINTENANCE AND RELIABILITY ANALYSIS CHART	PROJECT NO. 7-8-1018-06	NOMENCLATURE Marginal Terrain Assault Bridge with M113A1 Launcher	IDENTIFICATION NO. Serial Number 53

GP NO.	COMPONENT AND RELATED OPERATION	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL		TM INSTRUCTIONS		ACTIVE MAINT TIME	SYSTEM LIFE M-MILES H-HOURS R-ROUNDS	REASON PERFORMED	REMARKS
		PRESB	RECM	ADQT	INADQT				
1	2	3	4	5	6	7	8	9	10
4309 (9)	Replaced: Hydraulic Controls. (Levers)	0	0	X		0.5-MH 0.5-CH	215.3-M 24.0-H	Unsched	Failure. See EPR No KD-60. Launches - 283; crossings - 4,230
1508 (10)	Replaced: Bracing Cross Beams, etc., (Link Beam)	0	0	X		1.9-MH 0.9-CH	238.4-M 26.6-H	Unsched	Failure. See EPR No 86(16-4). Launches 316; crossings - 4,740
4301 (11)	Repaired: Strainers, Filter, Hose, etc., (Hose Retractor)	Not Presb	0	NA		1.3-MH 1.3-CH	263.6-M 30.2-H	Unsched	Failure. See EPR No KD-58. Deferred from 195.1 Miles/21.8 Hours. Launches - 375; crossings - 5,615
4305 (12)	Tested: Relief Valve, Master	Not Presb	0		EPR No KD-7 (Pub)	2.5-MH 1.0-CH	272.8-M 32.0-H	Unsched	See EPR No KD-66.
4302 (13)	Replaced: Pump, Hydraulic	0	0	X		4.0-MH 2.0-CH	272.8-M 32.0-H	Unsched	Failure. See EPR No KD-66. Launches - 375; crossings - 5,615
1508 (14)	Repaired: Bracing Cross Beams, etc.	Not Presb	0		EPR No KD-7(Pub)	4.0-MH 2.0-CH	293.6-M 34.4-H	Unsched	Failure. See EPR No KD-67. Launches - 389; crossings - 5,835
4301 (15)	Repaired: Strainers, Filters, Hoses, etc. (Screw Flathead) (Hose Retractor)	Not Presb	0		EPR No KD-7(Pub)	0.2-MH 0.1-CH	293.6-M 34.4-H	Unsched	Launches - 389; crossings - 5,834
1801 (16)	Repaired: Surfboards	Not Presb	0		EPR No KD-7(Pub)	0.2-MH 0.1-CH	293.6-M 34.4-H	Unsched	See EPR No KD-52. Launches - 389; crossings 5,835
4309 (17)	Repaired: Hydraulic Controls, (Welded)	F	F	X		0.2-MH 0.2-CH	327.1-M 39.7-H	Unsched	Failure. See EPR No KD-79(60-3). Launches 437; crossings - 6,555

MAINTENANCE AND RELIABILITY ANALYSIS CHART	PROJECT NO. 7-8-1018-06	NOMENCLATURE Marginal Terrain Assualt Bridge with M113A1 Launcher	IDENTIFICATION NO. Serial Number 53

GP NO.	COMPONENT AND RELATED OPERATIONS	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL		TM INSTRUCTIONS		ACTIVE MAINT TIME	SYSTEM LIFE M-MILES H-HOURS R-ROUNDS	REASON PERFORMED	REMARKS
		PRESB	RECM	ADQT	INADQT				
1	2	3	4	5	6	7	8	9	10
1508 (18)	Replaced: Pins Lock Bolts (Rotating Beam Retaining Bolt)	O	O	X		1.0-MH 0.5-CH	327.1-M 39.7-H	Unsched	Failure. See EPR No KD-80. Launches - 437; crossings - 6,555
4309 (19)	Repaired: Hydraulic Controls (Welded)	F	F	X		0.2-MH 0.2-CH	327.1-M 39.7-H (17)	Unsched	Failure. Launches - 437; crossings - 6,555
4301 (20)	Repaired: Strainers Filters, Hoses, etc. (Hose Retractor)	Not Presb	O		EPR No KD-7 (Pub)	0.2-MH 0.2-CH	327.1-M 39.7-H (11)	Unsched	Failure. See EPR No KD-76(58-3). Launches - 437; crossings - 6,555
1508 (21)	Replaced: Bracing Cross Beams, (Link Beam)	O	O	X		1.5-MH 0.7-CH	327.1-M 39.7-H (10)	Unsched	Failure. Launches - 437; crossings - 6,555
4305 (22)	Adjusted: Relief Valve, Master	F	O	X	EPR No KD-7 (Pub)	3.5-MH 2.5-CH	327.1-M 39.7-H (12)	Unsched	Launches - 437; crossings - 6,555
4309 (23)	Repaired: Hydraulic Controls, (Levers)	F	F	X		1.0-MH 1.0-CH	331.9-M 40.9-H (19)	Unsched	Failure. See EPR No KD-85(60-5). Launches - 445; crossings - 6,675
4309 (24)	Repaired: Hydraulic Controls (Welded)	F	F	X		0.3-MH 0.3-CH	342.4-M 41.8-H (24)	Unsched	Failure. See EPR No KD-88(60-6). Launches - 455; crossings - 6,825
1508 (25)	Replaced: Pins, Lock; Bolts (Rotating, Beam, Retaining Bolt)	O	O	X		1.4-MH 1.2-CH	343.2-M 42.0-H (18)	Unsched	Failure. See EPR No KD-91(80-4). Launches - 456; crossings - 6,830

EBB FORM 1014 1 Nov 66 (Rev)

USATECOM REGULATION 750-15

MAINTENANCE AND RELIABILITY ANALYSIS CHART	PROJECT NO. 7-8-1018-06	NOMENCLATURE Marginal Terrain Assualt Bridge with M113A1 Launcher	IDENTIFICATION NO. Serial Number 53

GP NO.	COMPONENT AND RELATED OPERATIONS	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL		TM INSTRUCTIONS		ACTIVE MAINT TIME	SYSTEM LIFE M-MILES H-HOURS R-ROUNDS	REASON PERFORMED	REMARKS
		PRESB	RECM	ADQT	INADQT				
1	2	3	4	5	6	7	8	9	10
1508 (26)	Repaired: Bracing Cross Beams, etc. (Bushings reinstalled)	Not Presb	O	X		0.5-MH 0.3-CH	343.2-M 42.0-H	Unsched	See EPR No KD-93. Launches - 456; crossings - 6,830
4309 (27)	Replaced: Hydraulic Control (Levers)	0	0	X		0.5-MH 0.5-CH	343.2-M 42.0-H (24)	Unsched	See EPR No KD-95. Launches - 456; crossings - 6,830
4305 (28)	Tested: Relief Valve Master (All)	Not Presb	0		EPR No KD-7 (Pub)	0.8-MH 0.7-CH	352.9-M 43.3-H (12)	Unsched	Launches - 472; crossings - 7,080
1508 (29)	Replaced: Pins, Lock, Bolts, (Rotating Beam Retaining Bolt.)	0	0	X		0.2-MH 0.1-CH	352.9-M 43.3-H (26)	Unsched	Failure. See EPR No KD-99(80-5). Launches - 472; crossings - 7,080
(30)	Q-Service (Vehicle)	0	0	X		9.9-MH 9.5-CH	353.4-M 43.3-H	Sched	Launches - 472; crossings - 7,080
(30a)	Q-Service (Launcher)	0	0	X		1.6-MH 0.8-CH	353.4-M 43.3-H	Sched	Launches - 472; crossings - 7,080
(30b)	Q-Service (Bridge)	0	0	X		1.4-MH 0.7-CH	353.4-M 43.3-H	Sched	Launches - 472; crossings - 7,080
1505 (31)	Repaired: Launcher Assy	Not Presb	0	X		3.2-MH 3.2-CH	356.9-M 44.2-H	Unsched	Launches - 472; crossings - 7,080 Repaired with engineer design change parts.
1508 (32)	Repaired: Bracing Cross Beams, etc. (Bridge)	Not Presb	0	X		4.5-MH 4.5-CH	356.9-M 44.2-H	Unsched	Launches - 472; crossings - 7,080. Repaired with engineer design change parts.

EBB FORM 1014 1 Nov 66 (Rev)

USATECOM REGULATION 750-15

MAINTENANCE AND RELIABILITY ANALYSIS CHART	PROJECT NO. 7-8-1018-06	NOMENCLATURE Marginal Terrain Assault Bridge with M113A1 Launcher	IDENTIFICATION NO. Serial Number 53

GP NO.	COMPONENT AND RELATED OPERATIONS	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL		TM INSTRUCTIONS		ACTIVE MAINT TIME	SYSTEM LIFE M-MILES H-HOURS R-ROUNDS	REASON PERFORMED	REMARKS
		PRESB	RECM	ADQT	INADQT				
1	2	3	4	5	6	7	8	9	10
4301 (33)	Replaced: Hoses and Rigid Hydraulic Lines	O	O	X		1.0-MH 0.5-CH	428.7-M 49.8-H	Unsched	See EPR No KD-104. Launches - 548; crossings - 8,220
1505 (34)	Repaired: Folding Assy (Welded Link, Sliding)	F	[illegible]	X		1.0-MH 1.0-CH	479.3-M 59.8-H	Unsched	Failure. See EPR No KD-106. Launches - 627; crossings 9,405
4309 (35)	Replaced: Hydraulic Controls (Levers)	O	O	X		0.4-MH 0.2-CH	484.3-M 59.4-H (25)	Unsched	Failure. See EPR No KD-107(60-7). Launches - 635; crossings - 9,525
4305 (36)	Adjusted: Relief Valve (All)	F	O		EPR No KD-7 (Pub)	1.5-MH 0.5-CH	484.9-M 60.9-H (23)	Unsched	See EPR No KD-108. Launches - 636; crossings - 9,530
1508 (37)	Repaired: Bracing Cross Beams, etc. (Welded, Ramp Flange Plate)	Not Presb	O		EPR No KD-7 (Pub) and KD-8 (Pub)	18.0-MH 9.0-CH	492.7 M 61.9-H	Unsched	Failure. See EPR No KD-110(67-2). The excessive time shown in column 7 for this repair operation was due to incorrect welding instructions. Launches - 647; crossings - 9,705.
1508 (38)	Replaced: Bracing, Cross Beams, etc. (Brace Vertical)	O	O	X		1.0-MH 0.5-CH	492.7-M 61.9-H (6)	Unsched	Launches - 647; crossings - 9,705
				TOTAL (Man-hours)		62.7			

EBB FORM 1014 1 Nov 66 (Rev)

USATECOM REGULATION 750-15

MAINTENANCE AND RELIABILITY ANALYSIS CHART (operator/crew only)	PROJECT NO. 7-8-1018-06	NOMENCLATURE Marginal Terrain Assualt Bridge with M113A1 Launcher	IDENTIFICATION NO. Serial Number 53

GP NO.	COMPONENT AND RELATED OPERATIONS	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL		TM INSTRUCTIONS		* MAINT TIME	SYSTEM LIFE M-MILES H-HOURS R-ROUNDS	REASON PERFORMED	REMARKS
		PRESB	RECM	ADQT	INADQT				
1	2	3	4	5	6	7	8	9	10
4309 (1)	Adjusted: Hydraulic Controls and/or Manual Controls, Arms, Levers, Knobs, Linkages	Not Presb	C	X		0.1-MH 0.1-CH	26.8-M 6.7-H	Unsched	See EPR No KD-8.
4301 (2)	Adjusted: Fittings and Quick-Disconnects	Not Presb	C	X		0.2-MH 0.2-CH	26.8-M 6.7-H	Unsched	See EPR No KD-9.
1508 (3)	Adjusted: Bracing Cross Beams, etc.	Not Presb	C	X		0.5-MH 0.3-CH	64.8-M 13.4-H	Unsched	See EPR No KD-29.
4307 (4)	Adjusted: Hydraulic Cylinders, Locking	Not Presb	C	X		0.1-MH 0.1-CH	64.8-M 13.4-H	Unsched	See EPR No 33(6-4).
4309 (5)	Adjusted: Hydraulic Controls and/or Manual Controls, Arms, Levers, Knobs, Linkages	Not Presb	C	X		0.1-MH 0.1-CH	344.5-M 42.2-H (1)	Unsched	See EPR No KD-96.
1505 (6)	Adjusted: Folding Assembly	Not Presb	C	X		0.2-MH 0.1-CH	443.9-M 54.5-H	Unsched	See EPR No KD-105.
4307 (7)	Adjusted: Hydraulic Cylinders, (Launching and Folding).	Not Presb	C	X		0.2-MH 0.2-CH	484.9-M 59.7-H	Unsched	See EPR No KD-109.

EBB FORM 1014 1 Nov 66 (Rev)

* Not charged as "active maintenance time"

USATECOM REGULATION 750-15

MAINTENANCE AND RELIABILITY ANALYSIS CHART	PROJECT NO. 7-8-1018-06	NOMENCLATURE Marginal Terrain Assualt Bridge with M113A1 Launcher	IDENTIFICATION NO. Serial Number 54

GP NO.	COMPONENT AND RELATED OPERATIONS	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL		TM INSTRUCTIONS		ACTIVE MAINT TIME	SYSTEM LIFE M-MILES H-HOURS R-ROUNDS	REASON PERFORMED	REMARKS
		PRESB	RECM	ADQT	INADQT				
1	2	3	4	5	6	7	8	9	10
1508 (1)	Replaced: Bracing Cross Beams, etc. (Vertical Brace)	O	O	X		0.4-MH 0.2-CH	5.2-M 0.1-H	Unsched	Failure. See EPR No KD-18. Launches - 7; crossings - 105.
1508 (2)	Replaced: Bracing Cross Beams, etc. (Link)	O	O	X		1.9-MH 0.9-CH	7.7-M 0.9-H	Unsched	Failure. See EPR No KD-19(16-2). Launches - 11, crossings - 165.
4308 (3)	Replaced: Reservoir, Hydraulic	O	O	X		4.0-MH 2.0-CH	12.8-M 1.3-H	Unsched	Failure. See EPR No KD-3. Launches - 11; crossings - 165
1508 (4)	Repaired: Bracing Cross Beams, etc.	Not Presb	O		EPR No KD-7 (Pub)	1.0-MH 1.0-CH	12.8-M 1.3-H	Unsched	
1801 (5)	Repaired: Mounts (Welded) (Hull Bushings)	Not Presb	O		EPR No KD-7 (Pub)	2.0-MH 1.0-CH	12.8-M 1.3-H	Unsched	
1505 (6)	Repaired: Tongue Assembly	D	F	X		1.0 MH 1.0-CH	20.8-M 1.6-H	Unsched	See EPR No KD-20. Launches - 11; crossings-165. This operation was performed at F level and the time required was charged to that level.
1508 (7)	Replaced: Bracing Cross Beams, etc. (Vertical Brace)	O	O	X		0.2-MH 0.2-CH	50.8-M 4.0-H	Unsched	Failure. See EPR No KD-41. Launches - 14; crossings - 210.
1508 (8)	Replaced: Bracing Cross Beams, etc. (Vertical Brace)	O	O	X		0.4-MH 0.2-CH	89.9-M 8.3-H (1)	Unsched	Failure. See EPR No KD-46. Launches - 70; crossings - 1,050.

EBB FORM 1014 1 Nov 66 (Rev)

USATECOM REGULATION 750-15

MAINTENANCE AND RELIABILITY ANALYSIS CHART	PROJECT NO. 7-8-1018-06	NOMENCLATURE Marginal Terrain Assualt Bridge with M113A1 Launcher	IDENTIFICATION NO. Serial Number 54

GF NO.	COMPONENT AND RELATED OPERATIONS	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL		TM INSTRUCTIONS		ACTIVE MAINT TIME	SYSTEM LIFE M-MILES H-HOURS R-ROUNDS	REASON PERFORMED	REMARKS
		PRESB	RECM	ADQT	INADQT				
1	2	3	4	5	6	7	8	9	10
1508 (9)	Replaced: Bracing Cross Beams, etc. (Hose Retractor Beam)	0	0	X		0.4-MH 0.2-CH	89.9-M 8.3-H	Unsched	Failure. (Simultaneous Related Failure) See EPR No KD-48. Launches - 70; crossings 1,050.
1505 (10)	Repaired: Folding Assembly	F	0	X		1.5-MH 0.7-CH	134.5-M 13.1-H	Unsched	Failure. See EPR No KD-55. Launches - 124; crossings - 1,845. This operation was performed at the O level and the time charged at that level.
4305 (11)	Tested: Relief Valve	Not Presb	0		EPR No KD-7 (Pub)	4.0-MH 2.0-CH	134.5-M 12.6-H	Unsched	Launches - 124; crossings - 1,845.
1801 (12)	Repaired: Surfboards	Not Presb	0		EPR No KD-7 (Pub)	0.5-MH 0.5-CH	135.3-M 13.8-H	Unsched	Failure. See EPR No KD-57 (52-3). Launches - 123; crossings - 1,845.
4309 (13)	Replaced: Hydraulic Controls, (Lever)	0	0	X		0.1-MH 0.1-CH	138.5-M 14.3-H	Unsched	Failure. See EPR No KD-63(60-2). Launches - 123; crossings - 1,845.
1508 (14)	Repaired: Pins, Lock, Bolts	Not Presb	0	X		0.8-MH 0.4-CH	138.5-M 14.3-H	Unsched	Tightened hose retractor retaining bolts.
4305 (15)	Tested: Relief Valves	Not Presb	0		EPR No KD-7 (Pub)	1.0-MH 0.5-CH	163.5-M 18.2-H (11)	Unsched	
4307 (16)	Replaced: Hydraulic Cylinder (Launching)	0	0	X		0.5-MH 0.3-CH	182.8-M 21.5-H	Unsched	Failure. See EPR No KD-70. Launches - 202; crossings - 3,030.
1508 (17)	Replaced: Bracing Cross Beams, etc. (Vertical Brace)	0	0	X		1.0-MH 1.0-CH	189.0-M 22.3-H (8)	Unsched	See EPR No KD-71. Launches - 213; crossings - 3,195.

EBB FORM 1014 1 Nov 66 (Rev)

USATECOM REGULATION 750-15

MAINTENANCE AND RELIABILITY ANALYSIS CHART	PROJECT NO. 7-8-1018-06	NOMENCLATURE Marginal Terrain Assualt Bridge with M113A1 Launcher	IDENTIFICATION NO. Serial Number 54

GP NO.	COMPONENT AND RELATED OPERATIONS	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL		TM INSTRUCTIONS		ACTIVE MAINT TIME	SYSTEM LIFE M-MILES H-HOURS R-ROUNDS	REASON PERFORMED	REMARKS
		PRESb	RECM	ADQT	INADQT				
1	2	3	4	5	6	7	8	9	10
4301 (18)	Replaced: Strainers, Filters, Hose, etc. (Hose Retractor)	Not Presb	0	X		0.5-MH 0.5-CH	193.7-M 23.0-H	Unsched	Failure. See EPR No KD-72. Launches - 222; crossings - 3,330.
1505 (19)	Adjusted: Launching Assembly (Retainer Plate)	Not Presb	0		EPR No KD-7 (Pub)	0.2-MH 0.2-CH	218.5-M 26.1-H	Unsched	See EPR No KD-73. Launches - 270; crossings 4,050.
4305 (20)	Replaced: Relief Valve (Folding Cyl)	0	0	X		0.1-MH 0.1-CH	218.5-M 26.1-H	Unsched	Failure. Launches - 270; crossings - 4,050. No EPR submitted.
4305 (21)	Tested: Relief Valves	Not Presb	0	X		4.5-MH 4.5-CH	218.5-M 26.1-H (15)	Unsched	Launches - 270; crossings - 4,050.
1508 (22)	Replaced: Pins, Lock, Bolts. (Rotating Beam)	0	0	X		1.0-MH 0.5-CH	256.4-M 31.5-H	Unsched	Failure. See EPR No KD-81(80-2). Launches - 339; crossings - 5,085.
4301 (23)	Repaired: Strainers, Filters, Hoses, etc. (Hose Retractor)	Not Presb	0		EPR No KD-7 (Pub)	0.2-MH 0.2-CH	256.4-M 31.5-H (18)	Unsched	Failure. See EPR No KD-82(58-4). Launches - 339; crossings - 5,085
1508 (24)	Replaced: Bracing Cross Beam, etc. (Link Beam)	0	0	X		1.0-MH 0.5-CH	262.0-M 32.7-H	Unsched	See EPR No KD-87. Launches - 349; crossings - 5,235.
4309 (25)	Repaired. Hydraulic Controls, (Levers)	0	0	X		0.2-MH 0.2-CH	262.0-M 32.7-H (13)	Unsched	Failure. See EPR No KD-84. Launches - 349; crossings - 5,235.

EBB FORM 1014 1 Nov 66 (Rev)

USATECOM REGULATION 750-15

MAINTENANCE AND RELIABILITY ANALYSIS CHART	PROJECT NO. 7-8-1018-06	NOMENCLATURE Marginal Terrain Assault Bridge with M113A1 Launcher	IDENTIFICATION NO. Serial Number 54

GP NO.	COMPONENT AND RELATED OPERATIONS	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL		TM INSTRUCTIONS		ACTIVE MAINT TIME	SYSTEM LIFE M-MILES H-HOURS R-ROUNDS	REASON PERFORMED	REMARKS
		PRESB	RECM	ADQT	INADQT				
1	2	3	4	5	6	7	8	9	10
4307 (26)	Replaced: Pins, Lock, Bolts: (Rotating Beam)	O	O	X		0.5-MH 0.5-CH	268.6-M 33.4-H (22)	Unsched	Failure. See EPR No KD-89(80-3). Launches - 353; crossings 5,295.
4305 (27)	Tested: Relief Valves	Not Presb	O		EPR No KD-7 (Pub)	4.4-MH 4.4-CH	269.9-M 33.6-H (21)	Unsched	
1508 (28)	Repaired: Bracing Cross Beams, etc. (Bushings Reinserted)	Not Presb	O	X		0.5-MH 0.3-CH	269.9-M 33.6-H	Unsched	See EPR No KD-94(93-2). Launches - 355; crossings - 5,325.
1508 (29)	Replaced: Pins, Lock, Bolts (Rotating Beam Retaining Bolt)	O	O	X		0.3-MH 0.3-MH	283.3-M 36.5-H (26)	Unsched	Failure. See EPR No KD-100(80-6), Launches - 376; crossings - 5,640.
4305 (30)	Tested: Relief Valves, (Hydraulic System)	Not Presb	O			2.2-MH 1.1-CH	283.3-M 36.5-H (27)	Unsched	Failure. See EPR No KD-98. Launches - 376; crossings 5,640.
4301 (31)	Strainers, Filter, Hoses, etc. (Hose Retractor	Not Presb	O	X		NA NA	283.3-M 36.5-H (23)	NA	Failure. See EPR No KD-90(58-5) No maintenance performed due to termination of test.
				TOTAL (Man-hours)		36.3			
	TOTAL ACTIVE MAINTENANCE TIME (Man-hours)					119.0			

EBB FORM 1014 1 Nov 66 (Rev)

USATECOM REGULATION 750-15

MAINTENANCE AND RELIABILITY ANALYSIS CHART (Operator/Crew Only)	PROJECT NO. 7-8-1018-06	NOMENCLATURE Marginal Terrain Assualt Bridge with M113A1 Launcher	IDENTIFICATION NO. Serial Number 54

GP NO.	COMPONENT AND RELATED OPERATIONS	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL		TM INSTRUCTIONS		* MAINT TIME	SYSTEM LIFE M-MILES H-HOURS R-ROUNDS	REASON PERFORMED	REMARKS
		PRESB	RECM	ADQT	INADQT				
1	2	3	4	5	6	7	8	9	10
4307 (1)	Adjusted: Hydraulic Cylinders, Locking	Not Presb	C	X		0.1-MH 0.1-CH	46.1-M 2.8-H	Unsched	See EPR No KD-32(6-3).
4301 (2)	Adjusted: Fittings and Quick-Disconnects	Not Presb	C	X		0.2-MH 0.2-CH	53.4-M 4.3-H	Unsched	See EPR No KD-42(9-2).

EBD FORM 1014 1 Nov 66 (Rev)

* Not charged as active maintenance time

USATECOM REGULATION 750-15

PART 1-C. DATA (SIMULATED OPERATIONS)

MAINTENANCE AND RELIABILITY ANALYSIS CHART	PROJECT NO. 7-8-1018-06	NOMENCLATURE Marginal Terrain Assault Bridge with M113A1 Launcher	IDENTIFICATION NO. NA

GP NO.	COMPONENT AND RELATED OPERATIONS	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL		TM INSTRUCTIONS		* MAINT TIME	SYSTEM LIFE M-MILES H-HOURS R-ROUNDS	REASON PERFORMED	REMARKS
		PRESB	RECM	ADRT	INADRT				
1	2	3	4	5	6	7	8	9	10
4305	Replaced: Valves, Check and Flow	O	O	X		0.1-MH 0.1-CH		Sim	
1505	Replaced: Folding Assembly	O	O	X		E2.0 E1.0		Sim	Reviewed - Not performed.
1505	Replaced: Tongue Assembly	F	F	X		E 2.0 E 1.0		Sim	Reviewed - Not performed.
1505	Replaced: Seat Assembly, Bridge	O	O	X		0.5-MH 0.5-CH		Sim	
1508	Replaced: Hinge, Folding	H	H	X		E 1.0 E 0.5		Sim	Reviewed - Not performed.
1801	Replaced: Mounts, Hull Bushings	F	F	X		0.5-MH 0.5-CH		Sim	
1801	Replaced: Surfboards	O	O	X		0.2-MH 0.2-CH		Sim	
4301	Replaced: Filter, Oil	O	O	X		0.5-MH 0.5-CH		Sim	
4302	Replaced: Universal Joint	O	O	X		1.3-MH 1.3-CH		Sim	
4305	Replaced: Manifold	O	O	X		E 0.8 E 0.8		Sim	Reviewed - Not performed.

EBB FORM 1014 1 Nov 66 (Rev) *Not charged as "active maintenance time"

USATECOM REGULATION 750-15

MAINTENANCE AND RELIABILITY ANALYSIS CHART	PROJECT NO. 7-8-1018-06	NOMENCLATURE Marginal Terrain Assualt Bridge with M113A1 Launcher	IDENTIFICATION NO. NA

GP NO.	COMPONENT AND RELATED OPERATIONS	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL		TM INSTRUCTIONS		* MAINT TIME	SYSTEM LIFE M-MILES H-HOURS R-ROUNDS	REASON PERFORMED	REMARKS
		PRESB	RECM	ADQT	INADQT				
1	2	3	4	5	6	7	8	9	10
4305	Replaced: Valve Bank Assembly	O	O	X		1.0-MH 1.0-CH		Sim	
4308	Replaced: Breather, Cap, Cover Gasket	O	O	X		0.1-MH 0.1-CH		Sim	
1508	Removed: Bridge Assy	Not Presb	O	X		7.5-MH 2.5-CH		Sim	
4307	Replaced. Hydraulic Cylinder, Locking	O	O	X		0.2-MH 0.2-CH		Sim	

EBE FORM 1014 1 Nov 66 (Rev) *Not charged as "active maintenance time" USATECOM REGULATION 750-15

PART 2-A

PARTS ANALYSIS CHART INSTRUCTION SHEET

GENERAL: Parts are listed on charts by functional groups and in numerical order within groups.

COLUMN	DESCRIPTION
1	Group Number, Cross Reference. Parts usage by maintenance operation is indicated by a cross reference to the group number and sequence number from Column 1 of the Maintenance and Reliability Analysis Chart.
2	Federal Stock Number, Technical Service Part Number, Manufacturers' Part Number, or Drawing Number. The number of parts used is shown in parenthesis.
3	Noun Nomenclature. As listed in the parts manual.
4	Maintenance Level, Prescribed. Maintenance level as prescribed by the parts list under review: C - Operator/Crew; O - Organizational; F - Direct Support; H - General Support.
5	Maintenance Level, Recommended. Maintenance level recommended by the test agency.
6	Part Life. The number of hours/miles accumulated before or since this part was replaced.
7	Reason Used. The symbol "Unsched" is shown in this column if the part used was a result of unscheduled maintenance. If the part used was the result of scheduled maintenance, the symbol "Sched" is used. If the part was consumed to verify procedures of tools, not as a result of breakdown, the symbol "Sim" is used.
8	Remarks. If an EPR was related to the part used, the EPR number is shown in this column. The notation "Failure" indicates parts replaced as a result of a failure.

PART 2-B. DATA

PARTS ANALYSIS CHART	PROJECT NO.	NOMENCLATURE	IDENTIFICATION NO.
	7-8-1018-06	Marginal Terrain Assault Bridge with M113A1 Launcher	Serial Number 53

(SEQUENCE NO) GP NO.	FEDERAL STOCK NUMBER	NOUN NOMENCLATURE	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL PRESB	RECM	PART LIFE M - MILES H HOURS R - ROUNDS	REASON USED	REMARKS
1	2	3	4	5	6	7	8
0106 (30)	2940-555-6348 (1 ea)	Element, Fluid Pressure (Oil)	0	0	353.9-M 43.3-H	Sched	Q-Service
0309 (30)	2910-745-7730 (1 ea)	Filter, Fuel	0	0	353.4-M 43.3-H	Sched	Q-Service
1508 (10)	5420-880-2783 (1 ea)	Beam, Link	0	0	238.4-M 26.6-H	Unsched	Failure. See EPR No 86(16-4).
1508 (32)	982525 (6 ea)	Hinge Pin	0	0	356.9-M 44.2-H	Unsched	Engineer design change.
1508 (32)	982564 (6 ea)	Nut, Castle (Shear Pin)	0	0	356.9-M 44.2-H	Unsched	Engineer design change.
1508 (32)	982565 (3 ea)	Nut, Castle (Shear Pin)	0	0	356.9-M 44.2-H	Unsched	Engineer design charge.
1508 (32)	982566 (3 ea)	Washer (Shear Pin)	0	0	356.9-M 44.2-H	Unsched	Engineer design change.
1508 (31)	9825 (2 ea)	Cap Screw	0	0	356.9-M 44.2-H	Unsched	Engineer design change.
1508 (27)	982568 (8 ea)	Cap Screw	0	0	356.9-M 44.2-H	Unsched	Engineer design change.
1508 (31)	982569 (4 ea)	Cap Screw	0	0	356.9-M 44.2-H	Unsched	Engineer design change.

EMB FORM 1013 1 Nov 66 (Rev)

PARTS ANALYSIS CHART	PROJECT NO. 7-8-1018-06	NOMENCLATURE Marginal Terrain Assault Bridge with M113A1 Launcher					IDENTIFICATION NO. Serial Number 53
(SEQUENCE NO) GP NO.	FEDERAL STOCK NUMBER	NOUN NOMENCLATURE	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL PRESB	RECM	PART LIFE M - MILES H - HOURS R - ROUNDS	REASON USED	REMARKS
1	2	3	4	5	6	7	8
1508 (31)	982570 (1 ea)	Cylinder Beam "PIN"	0	0	356.9-M 44.2-H	Unsched	Engineer design change.
1508 (32)	982571 (2 ea)	Pin, Rotating Beam	0	0	356.9-M 44.2-H	Unsched	Engineer design change.
1508 (32)	982573 (1 ea)	Pin, Link Beam	0	0	356.9-M 44.2-H	Unsched	Engineer design change.
1508 (32)	982572 (1 ea)	Pin, Clevis	0	0	356.9-M 44.2-H	Unsched	Engineer design change.
1508 (32)	982574 (1 ea)	Spacer, Link Beam	0	0	356.9-M 44.2-H	Unsched	Engineer design change.
1508 (32)	982575 (1 ea)	Spacer, Link Beam	0	0	356.9-M 44.2-H	Unsched	Engineer design change.
1508 (32)	982576 (4 ea)	Hose Retractor	0	0	356.9-M 44.2-H	Unsched	Engineer design change.
1508 (32)	982577 (8 ea)	Angle, Hose Retractor	0	0	356.9-M 44.2-H	Unsched	Engineer design change.
1508 (32)	982578 (4 ea)	Beam Mount	0	0	356.9-M 44.2-H	Unsched	Engineer design change.
1508 (32)	982579 (2 ea)	Spacer	0	0	356.9-M 44.2-H	Unsched	Engineer design change.

EBB FORM 1013 1 Nov 66 (Rev)

USATECOM REGULATION 750-15

PARTS ANALYSIS CHART	PROJECT NO. 7-8-1018-06	NOMENCLATURE Marginal Terrain Assault Bridge with M113A1 Launcher	IDENTIFICATION NO. Serial Number 53

(SEQUENCE NO) GF NO.	FEDERAL STOCK NUMBER	NOUN NOMENCLATURE	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL PRESB	DECM	PART LIFE M - MILES H HOURS R - ROUNDS	REASON USED	REMARKS
1	2	3	4	5	6	7	8
1508 (32)	982293 (2 ea)	Nut, Self Locking	0	0	356.9-M 44.2-H	Unsched	Engineer design change.
1508 (16)	5420-880-2639 (2 ea)	Brace, Vertical	0	0	160.7-M 18.2-H	Unsched	Failure. See EPR No KD-50(18-4).
1508 (18)	982524 (2 ea)	Bolt, Retaining, Rotating Beam	0	0	327.1-M 39.7-H	Unsched	See EPR No KD-80.
1508 (29)	982524 (1 ea)	Bolt, Retaining, Rotating Beam	0	0	9.7-M 1.3-H	Unsched	Failure. See EPR No KD-99(80-5).
1508 (25)	982524 (1 ea)	Bolt, Retaining, Rotating Beam	0	0	16.1-M 2.3-H	Unsched	Failure. See EPR No KD-91(80-4).
1508 (25)	5315-298-1481 (1 ea)	Pin Cotter	0	0	343.2-M 42.0-H	Unsched	See EPR No KD-91(80-4).
1508 (5)	5420-880-2672 (1 ea)	Beam, Rotating	0	0	160.7-M 18.2-H	Unsched	
1508 (21)	5420-880-2783 (1 ea)	Beam, Link	0	0	88.7-M 13.1-H	Unsched	Failure.
1508 (2)	5420-880-2783 (1 ea)	Beam, Link	0	0	51.0-M 7.8-H	Unsched	Failure. See EPR No KD-16.
1508 (3)	5420-880-2780 (1 ea)	Beam, Cylinder	0	0	51.0-M 7.8-H	Unsched	Failure. See EPR No KD-17.
1508 (4)	5420-880-2783 (1 ea)	Beam, Link	0	0	0-M 0-H	Unsched	Failure. See EPR No KD-40(16-3)

EBB FORM 1013 1 Nov 66 (Rev)

USATECOM REGULATION 750-15

PARTS ANALYSIS CHART	PROJECT NO. 7-8-1018-06	NOMENCLATURE Marginal Terrain Assault Bridge with M113A1 Launcher					IDENTIFICATION NO. Serial Number 53
(SEQUENCE NO) GP NO.	FEDERAL STOCK NUMBER	NOUN NOMENCLATURE	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL PRESB	ECM	PART LIFE M - MILES H HOURS R - ROUNDS	REASON USED	REMARKS
1	2	3	4	5	6	7	8
1508 (38)	5420-880-2646 (1 ea)	Brace, Vertical	0	0	332.0-M 43.7-H	Unsched	
1508 (6)	5420-880-2646 (2 ea)	Brace, Vertical	0	0	160.7-M 18.2-H	Unsched	See EPR No KD-50(18-4)
1508 (29)	982521 (1 ea)	Nut, Retaining, Rotating Beam	0	0	19.8-M 2.3-H	Unsched	Failure. See EPR No KD-99(80-5).
1508 (18)	982521 (2 ea)	Nuts, Retaining, Rotating Beam	0	0	327.1-M 39.7-H	Unsched	Failure. See EPR No KD-80.
1801 (16)	5420-880-2703 (1 ea)	Pin, Surfboard	0	0	293.6-M 34.4-H	Unsched	See EPR No KD-52.
4301 (4)	11546-17-14 (1 ea)	Adapter, Steel	0	0	172.2-M 19.3-H	Unsched	
4301 (20)	11546-19-2 (1 ea)	Hose, Retractor	0	0	63.5-M 9.5-H	Unsched	Failure. See EPR No KD-76(58-3).
4301 (11)	11546-19-2 (1 ea)	Hose, Retractor,	0	0	195.1-M 21.8-H	Unsched	Failure. Deferred, not replaced until 263.6-M/ 30.2-H.
4301 (15)	5305-057-9597 (1 ea)	Screw, Flat Head, Hose Retractor	0	0	293.6-M 34.4-H	Unsched	
4301 (33)	5420-880-2815 (1 ea)	Tube (30 ft. stock)	0	0	428.7-M 59.8-H	Unsched	See EPR No KD-104.

EBB FORM 1013 1 Nov 66 (Rev)

USATECOM REGULATION 750-15

PARTS ANALYSIS CHART	PROJECT NO. 7-8-1018-06	NOMENCLATURE Marginal Terrain Assault Bridge with M113A1 Launcher					IDENTIFICATION NO. Serial Number 53
(SEQUENCE NO) GP NO.	FEDERAL STOCK NUMBER	NOUN NOMENCLATURE	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL PRESB	RECM	PART LIFE M - MILES H HOURS R - ROUNDS	REASON USED	REMARKS
1	2	3	4	5	6	7	8
4302 (13)	5420-880-2882 (1 ea)	Pump, Hyd	0	0	271.6-M 31.4-H	Unsched	Failure. See EPR No KD-66.
4308 (1)	982077 (1 ea)	Reservoir, Hydraulic	0	0	47.8-M 1.2-H	Unsched	Failure. See EPR No KD-15 and KD-49.
4308 (1)	982297 (1 ea)	Lock Washer	0	0	47.8-M 1.2-H	Unsched	See EPR No KD-68.
4308 (1)	9823513 (3 ea)	Flat Washer	0	0	47.8-M 1.2-H	Unsched	See EPR No KD-68.
4308 (1)	982552 (2 ea)	Rubber Pads Mounts	0	0	47.8-M 1.2-H	Unsched	See EPR No KD-68
4308 (1)	9825510 (3 ea)	Cap Screw	0	0	47.8-M 1.2-H	Unsched	See EPR No KD-68.
4309 (27)	982103 (1 ea)	Handle, Control Launching	0	0	127.9-M 18.0-H	Unsched	See EPR No KD-95.
4309 (27)	982105 (1 ea)	Handle, Control Folding	0	0	343.2-M 42.0-H	Unsched	See EPR No KD-95.
4309 (27)	982106 (1 ea)	Handle, Control Locking	0	0	343.2-M 42.0-H	Unsched	See EPR No KD-95.
4309 (27)	982554 (1 ea)	Lock, Control Handles (Hyd Sys)	Not Presb	0	343.2-M 42.0-H	Unsched	See EPR No KD-95.

EBB FORM 1013 1 Nov 66 (Rev)

USATECOM REGULATION 750-15

PARTS ANALYSIS CHART	PROJECT NO. 7-8-1018-06	NOMENCLATURE Marginal Terrain Assault Bridge with M113A1 Launcher	IDENTIFICATION NO. Serial Number 53

(SEQUENCE NO) GP NO.	FEDERAL STOCK NUMBER	NOUN NOMENCLATURE	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL PRESB	RECM	PART LIFE M - MILES H HOURS R - ROUNDS	REASON USED	REMARKS
1	2	3	4	5	6	7	8
4309 (35)	11545-21-4 (1 ea)	Handle, Launching	0	0	127.4-M 15.2-H	Unsched	Failure. See EPR No KD-107.
4309 (9)	11545-21-4 (1 ea)	Handle, Launching	0	0	215.3-M 24.0-H	Unsched	Failure. See EPR No 60.

EBB FORM 1013 1 Nov 66 (Rev)

USATECOM REGULATION 750-15

PARTS ANALYSIS CHART	PROJECT NO. 7-8-1018-06	NOMENCLATURE Marginal Terrain Assault Bridge with M113A1 Launcher					IDENTIFICATION NO. Serial Number 54
(SEQUENCE NO) GP NO.	FEDERAL STOCK NUMBER	NOUN NOMENCLATURE	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL PRESB	RECM	PART LIFE M - MILES H HOURS R - ROUNDS	REASON USED	REMARKS
1	2	3	4	5	6	7	8
1505 (10)	5420-880-2719 (1 ea)	Link, Tensile	F	0	134.5-M 13.1-H	Unsched	Failure. See EPR No KD-55.
1508 (1)	5420-880-2639 (1 ea)	Brace, Vertical	0	0	5.2-M 0.1-H	Unsched	Failure. See EPR No KD-18.
1508 (2)	5420-880-2783 (1 ea)	Beam, Link	0	0	7.7-M 0.9-H	Unsched	Failure. See EPR No KD-19(16-2).
1508 (29)	982524 (1 ea)	Bolt, Retaining, Rotating Beam	0	0	26.9-M 5.0-H	Unsched	Failure. See EPR No KD-100(80-6).
1508 (7)	5420-880-2639 (1 ea)	Brace, Vertical	0	0	50.8-M 4.0-H	Unsched	Failure. See EPR No KD-41.
1508 (8)	5420-880-2639 (2 ea)	Brace, Vertical	0	0	39.1-M 4.3-H	Unsched	Failure. See EPR No KD-46. Only one brace failed...Replaced other one with mod brace.
1508 (8)	5420-880-2646 (2 ea)	Brace, Vertical	0	0	89.9-M 8.3-H	Unsched	See EPR No KD-46.
1508 (9)	NSN (1 ea)	Beam, Hose Retractor	0	0	89.9-M 8.3-H	Unsched	Simultaneous related failure. See EPR No KD-48.
1508 (17)	5420-880-2646 (1 ea)	Brace, Vertical	0	0	189.0-M 22.3-H	Unsched	See EPR No KD-71.

ERB FORM 1013 1 Nov 66 (Rev)

PARTS ANALYSIS CHART	PROJECT NO. 7-8-1018-06	NOMENCLATURE Marginal Terrain Assault Bridge with M113A1 Launcher					IDENTIFICATION NO. Serial Number 54
(SEQUENCE NO) GP NO.	FEDERAL STOCK NUMBER	NOUN NOMENCLATURE	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL PRESB	RECM	PART LIFE M - MILES H - HOURS R - ROUNDS	REASON USED	REMARKS
1	2	3	4	5	6	7	8
1508 (22)	982521 (1 ea)	Nut, Retaining, Rotating Beam	0	0	256.4-M 31.5-H	Unsched	See EPR No KD-81.
1508 (22)	982524 (1 ea)	Bolt, Retaining, Rotating Beam	0	0	256.4-M 31.5-H	Unsched	Failure. See EPR No KD-81(80-2).
1508 (24)	5420-880-2783 (1 ea)	Link Beam	0	0	262.0-M 32.7-H	Unsched	See EPR No KD-87.
1801 (12)	11545-27-4 (1 ea)	Mount, Lower	0	0	135.3-M 13.8-H	Unsched	Failure. See EPR No KD-57(52-3).
4301 (23)	11546-19-2 (1 ea)	Hose, Retractor	0	0	62.7-M 8.5-H	Unsched	Failure. See EPR No KD-82(58-4).
4301 (18)	11546-19-2 (1 ea)	Hose, Retractor	0	0	193.7-M 23.0-H	Unsched	Failure. See EPR No KD-72.
4305 (20)	5120-880-2905 (1 ea)	Relief Valve, Folding Cyl	0	0	218.5-M 26.1-H	Unsched	Failure. No EPR submitted.
4307 (15)	5420-880-2728 (1 ea)	Cylinder Assy (launching)	0	0	182.8-M 21.5-H	Unsched	Failure. See EPR No KD-70.
4308 (3)	982077 (1 ea)	Reservoir, Hyd	0	0	12.8-M 1.3-H	Unsched	Failure. See EPR No KD-3.
4308 (3)	982552 (2 ea)	Rubber Pads, Mounting, Hyd Reservoir	0	0	12.8-M 1.3-H	Unsched	See EPR No KD-3.

EBB FORM 1013 1 Nov 66 (Rev)

USATECOM REGULATION 750-15

PARTS ANALYSIS CHART	PROJECT NO. 7-8-1018-06	NOMENCLATURE Marginal Terrain Assault Bridge with M113A1 Launcher					IDENTIFICATION NO. Serial Number 54
(SEQUENCE NO) GP NO.	FEDERAL STOCK NUMBER	NOUN NOMENCLATURE	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL PRESB	RECM	PART LIFE M - MILES H - HOURS R - ROUNDS	REASON USED	REMARKS
1	2	3	4	5	6	7	8
4308 (3)	9825510 (1 ea)	Cap Screw, Hy Reservoir	0	0	12.8-M 1.3-H	Unsched	See EPR No KD-3.
4308 (3)	9823513 (3 ea)	Flat Washer, Mounting, Hyd Reservoir	0	0	12.8-M 1.3-H	Unsched	See EPR No KD-3.
4308 (3)	982297 (3 ea)	Lock Washer, Hyd Reservoir	0	0	12.8-M 1.3-H	Unsched	See EPR No KD-3.
4309 (13)	11545-21-4 (1 ea)	Handle, Launcher	0	0	138.5-M 14.3-H	Unsched	Failure. See EPR No KD-63(60-2).

EBB FORM 1013 1 Nov 66 (Rev)

USATECOM REGULATION 750-15

APPENDIX V. REFERENCES

1. Ltr, AMSTE-GE, 7-8-1018-05/06, HQ USATECOM, 6 Feb 68, subject: Test Directive, Initial Production Test of Marginal Terrain Assault Bridge with M113 Launcher, USATECOM Project No 7-8-1018-05/06, w 1 incl, and Amendment No 1, 13 Jun 68.

2. USAARENBD Plan of Initital Production Test of Marginal Terrain Assault Bridge with M113 Launcher, USATECOM Project No 7-8-1018-06, 10 Oct 68, w Change 1, 15 Nov 68.

3. Msg, TEC 4275, AMSTE-GE, HQ USATECOM, 22 Nov 68, subject: IPT of Marginal Terrain Assault Bridge with M113 Launcher, USATECOM Project No. 7-8-1018-05/06.

4. Msg, AEB 230, STEBB-EN-P, USAARENBD, 1 Feb 69, subject: Abbreviated Initial Production Test of Marginal Terrain Assault Bridge with M113 Launcher, USATECOM Project No 7-8-1018-06, Contract No. DAAK02-68-C-0226.

5. USAMC Regulation No 700-34, Logistics, Release of End Items for Issue, 3 Apr 67.

6. Ltr, AMSTE-GE, HQ USATECOM, 11 Feb 69, subject: Initial Production Test of Marginal Terrain Assault Bridge with M113 Launcher, USATECOM Project No. 7-8-1018-05/06.

7. Ltr, AMSTE-GE, HQ USATECOM, 28 Aug 68, subject: Proposed Plan for Initial Production Test of Marginal Terrain Assault Bridge with M113 Launcher, USATECOM Project No 7-8-1018-06.

8. Ltr, AMSTE-GE, HQ USATECOM, 9 Jan 68, subject: Coordinated Test Program-Marginal Terrain Assault Bridge with M113 Launcher, w 1 incl.

9. Ltr, AMCRD-GS, HQ USAMC, 22 May 68, subject: Coordinated Test Program for M113A1 Bridge/Launcher, w 1 incl.

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13. ABSTRACT The test objective was to conduct service-type testing as required to insure that the test item is suitable for issue to troops under provisions of AMCR 700-34. The two test items accumulated a total of 99.7 test hours (80.7 hours before major modification and 19 hours after major modification) and 777.4 miles. Testing consisted of road operations (20.6 hours), swimming (2.6 hours), and launching/retrieving operations (76.5 hours) and was conducted under all local environmental weather conditions to include both day and night operations. The test items satisfied the essential requirement relating to human factors engineering. The essential requirements relating to road mobility, cross-country mobility, compatibility with related equipment, fuel and oil consumption, and launching and recovery were either not determined or not fully determined due to test termination. The test items failed to fully satify the essential requirements relating to physical characteristics, launching and recovery, maintainability, and reliability. Seventeen deficiencies were encountered during the test. Nine were against the bridge, seven were against the launcher and one pertained to a safety hazard in that emergency evacuation in the event of sinking was considered inadequate. The deficiencies pertained to link beam flanges and mounts, cylinder beam to include bushings, vertical braces, hydraulic reservoir, tensile link, surfboard mounts, hose retractors, sliding link, rotating beam retaining bolts, and the hydraulic system to include the pump. One test item received modification at 44.2 test hours to correct repeated failures. The other test item became deadlined at 38.5 test hours and remained in that status until test termination. Of the seven modifications applied during test, two proved unsatisfactory (launch handle and cylinder beam bushings), one proved satisfactory (hydraulic reservoir), and four could not be

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14. KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
Marginal Terrain						
Assault Bridge						
Launchings						
Crossings						
M One One Three A One						
APC						

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ITEM 13 (cont)

thoroughly evaluated due to test termination. The overall reliability for a 12-hour mission at 90 percent confidence was computed to be 35 percent before and 47 percent after major modification. The overall MTBF was 23.55 launches before and 58.33 launches after major modification. The overall MTTR was .67 clock-hours before and 3.40 clock-hours after modification. The overall maintenance ratio was 1.19 before and 1.21 after major modification. It was concluded that the test item as received and as modified during test is unsuitable for troop issue.